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ABSTRACT

This report contains the results of a regional seminar on computers in education organized by the National Institute for Educational Research (NIER) of Japan. In an effort to promote international cooperation and the sharing of information, 15 participants from 12 countries (Australia, Brunei Darussalam, People's Republic of China, India, Japan, Malaysia, New Zealand, the Philippines, Republic of Korea, Singapore, Sri Lanka, and Thailand) reviewed the state of computers in education in their countries; examined the results of studies on computers in education, including one initiated and coordinated by the International Association for the Evaluation of Educational Achievement (IEA); and identified general issues, problems, and concerns that are common to all. It is noted that areas identified fall within the categories of policy, hardware, software/courseware, teacher development, and general. A discussion of the problems, issues, and suggested strategies for solving problems is followed by suggested recommendations. Also included are a list of participants and their addresses, and individual reports outlining the uses of computers in education in each country. (DB)

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TOMORROW'S TOOLS TODAY:

The state of educational computing in Asia and the Pacific

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Tomorrow's Tools Today:

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A Report of the Regional Seminar
(13 - 27 June 1990)

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Chapter 1: Introduction

In recent years computers have been introduced in schools in ever-increasing numbers in the countries of the Asian and Pacific region. There is a growing awareness of the importance of educational computing in this region and a desire to ensure that the limited resources available for education are used effectively. A number of studies on the use of computers in education have been undertaken in various countries of the region. Recently an international study has also been undertaken by the International Association for the Evaluation of Educational Achievement (IEA).

The National Institute for Educational Research (NIER) of Japan, in an effort to promote international co-operation and the sharing of information, organised a Regional Seminar on Computers in Education from 13 to 27 June 1990. Participants from twelve countries of the region, and the International coordinator of the IEA Computers in Education study were invited to attend.

Objectives

The objectives of the Seminar were as follows:

- 1) to review the state of computers in education in the participating countries;
- 2) to examine the results of studies on computers in education including the one initiated and coordinated by the International Association for the Evaluation of Educational Achievement (IEA) with the participation of about twenty countries in the world; and
- 3) to identify common problems, issues and trends in respect of computers in education and suggest strategies to deal with these.

Participants

Fifteen participants attended this Seminar from Australia, Brunei Darussalam, People's Republic of China, India, Japan, Malaysia, New Zealand, Philippines, Republic of Korea (2), Singapore (2), Sri Lanka, Thailand (2). The International Coordinator for the IEA Computers in Education Study also participated. The participants were all actively involved in educational computing in varying capacities in their respective countries (See Appendix A).

The Inaugural Session

The inaugural address was given by Mr. Hiromitsu Takizawa, the Director General of the National Institute for Educational Research, Japan.

After the inaugural address the participants introduced themselves. Following this the officers of the Seminar were elected.

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Officers of the Seminar

Chairperson:	Mr. Jim Ferguson (New Zealand)
Vice-Chairpersons:	Prof. Huh Unna (Republic of Korea) Dr. Sangob Laksana (Thailand)
Rapporteurs:	Prof. Carmela Perez (Philippines) Ms. Tang Wai Yee (Singapore)

Immediately after the election of officers the Seminar adjourned and a steering committee meeting was held to consider the proposed organisation of the Seminar and the schedule of work.

Organization and Schedule of Work

During the next two days of the seminar the participants from each country presented their reports. This was followed by a discussion on the current problems, trends and issues in the different countries.

The following day was entirely devoted to the presentation, by the International Coordinator, Dr. Hans Pelgrum, of facts, figures and insights gained from the data collected from the first stage of the IEA Study on Computers in Education. Some lively discussion on the interpretation of the initial results for stage 1 and the design for stage 2 ensued. During the day the second stage of the study, which will take place from 1991 to 1994, was described.

The next morning the participants were divided into two groups and each group prepared a paper on the problems, issues, and trends that had been highlighted in the preceding days of the Seminar.

Following this it was decided that four working groups would be established. One of these groups would prepare an overview of the state of educational computing in the region as shown by the reports presented to the Seminar. The other three groups would expand on relevant issues.

The work of each of these groups was then presented to the plenary session for discussion. The amended papers were then approved by the Seminar and form a part of this report.

A final draft of the report was presented to the Seminar and was adopted.

Chapter 2: Overview of Computers in Education in the Region

Position papers were presented by fifteen participants representing countries which are vastly different in geographical area, population, economic status and the centrality of government control of education. Each country also had a different time span of experience in the use of computers in education. Nevertheless, despite these great disparities and the fact that countries may have differences in their approaches to policy development and implementation, there are general issues, problems and concerns which are common to all. These fall within the following categories:

- A. Policy
- B. Hardware
- C. Software/Courseware
- D. Teacher development
- E. General

This overview is a synthesis of the experiences outlined in the country papers. (For further details, see Appendix B: Country Reports.) References have also been made to the IEA Computers in Education report which covers 22 countries, including four from this region (See Appendix C).

A. POLICY

Every country intends to introduce computers into schools, but the scope, emphasis and degree of available resources varies greatly. Some governments have a clearly articulated policy regarding the implementation and use of computers in education. Singapore offers an example of extensive forward planning which provides the foundation and framework for future advances. Some countries have different emphases for elementary and secondary schools.

a) Goals and Objectives

Most countries have identified the following categories of computer use in schools:

- * learning about computers.
- * using computers as tools to accomplish specific tasks (word processing, graphic design, communications software etc.).
- * integrating the use of computers into the existing curriculum.
- * using computers for administrative purposes.

b) Funding

In some countries funding for the introduction of computers in education is entirely or partially provided by the state, while in others no government funds are made available. In the more economically developed countries some financial support is usually given by parent and community organisations. This is not the case in developing countries where very often the entire responsibility for financing such a programme rests with the

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government.

c) Major Trends

The general trend among countries with longer experience of using computers in education has been to move away from learning about computers to learning with computers, especially in elementary schools. This trend has also been observed in United States' schools. Becker (1990) reports that in primary schools the proportion of teachers seeing computers from the "tool" perspective has increased from 19% to 31% between 1985 and 1989. In high schools the percentage of teachers who have adopted this perspective has increased from 32% to 49%.

It has been found in a few countries in the region that the best way for younger children to learn about computers is by integrating them into the curriculum. The IEA data shows that where countries use computers in elementary education, the trend is towards tool applications, with some emphasis on remediation and enrichment. In secondary schools, however, computers are still mainly used for learning about computers and are seldom used as tools within and across subject areas.

New Zealand has demonstrated that the extensive use of word processing in all classrooms not only enables students to become familiar with computers, but also helps to integrate their use as a learning tool across the curriculum. The trend towards the use of word processors may exemplify an emerging trend towards an extended use of generic software in education, for example the use of integrated tool packages in vocational and technical schools in the Philippines. Because they are confident in the use of these tools, Filipino students are well prepared to enter the workforce.

Some countries which have only recently introduced computers into schools have used them in the context of extra-curricula activities, to be undertaken outside school hours at the initiative of the teacher and the students. However, experience seems to show that subjects not included in the curriculum and not examinable are not given adequate attention. Where computer use has not been introduced into the existing curriculum, expected outcomes such as extensive student participation and competency level in computer use do not appear to have been achieved.

Almost every country encourages students at the secondary level to undertake computer studies/science courses. Thailand seems to be the only country to introduce ten elective courses at this level. At the secondary level there is also an increasing trend towards the use of computers as an instructional tool in vocational and technological studies. This creates useful links between schools, industry and commerce. Malaysia has undertaken pioneering work in this area. However, not many countries appear to have exploited this potential as yet.

Australia reports that computer technology has significantly changed the delivery of education to students in remote areas. Educators are experimenting with the use of different and innovative modes of delivery such as electronic voice/data/video communications, electronic blackboards, interactive TV broadcasting, FM sub-carrier radio, loudspeaker telephone terminals,

Chapter 2: Overview of Computers in Education in the Region

facsimile machines and beamed microwave links. It is anticipated that satellite communications, lap-top computers and the use of interactive video links will continue to revolutionise distance education.

Use of the computer as a vehicle for school administration and management is increasing. Singapore presents a comprehensive report on a totally automated system which could provide an excellent model for others who wish to move into this area.

B. HARDWARE

a) Number of Computers

The experience of all countries is that computers are first introduced into the secondary sector. In a few countries every secondary school now has access to a number of computer systems. In others coverage is limited in terms of the number of schools, levels of educational use, as well as in student/computer ratio. In most countries the student/computer ratio is considered unsatisfactory. In some cases governmental initiative is only at the planning stage and availability of computers, if it exists at all, exists only in the private schools.

From the country reports no consensus appears to have emerged on the optimum pupil/computer ratio. There is no uniformity in this area and different patterns can be observed in different countries. The availability of resources seems to be the major determinant of goals.

b) Standardisation

There is a movement toward the standardisation of computers in most countries. Lack of standardisation may lead to problems relating to maintenance as well as exacerbating the problems of software generation and acquisition. On the other hand, lack of standardisation may lead to the availability of a wider range of software and provide a hedge against obsolescence.

c) Placement of Computers

Although computers are located in laboratories in secondary schools for the purpose of computer studies, many countries feel that their placement in classrooms should also be considered to facilitate their use in daily lessons. Elementary schools in many countries are leading this trend. As the average number of computers in a school increases, so does the tendency to place them in classrooms.

C. SOFTWARE/COURSEWARE

a) Availability

There seems to be a universal lack of appropriate software. This was

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also found in the IEA study in elementary and secondary schools. There is also little agreement about what should constitute a "starter" set of software packages. It seems that the potential of available generic software such as word processing, graphic design packages, music programs and communications software has not yet been fully realised. For instance, the IEA study shows that only a small minority of schools in most countries possess computer communication software. In most countries, schools do not possess music composition programs, although France and New Zealand seem to be exceptions (about one-third of the schools have these programs.)

b) Production of Software

Most of the available software has been developed by hardware manufacturers or commercial software development houses. Some countries have set up software development units specifically for the production of educational software. Despite their small size, Sri Lanka and Singapore have both launched major initiatives in software production. India and the Republic of Korea have also been developing educational software at government level.

Many countries encourage teachers to produce software. However two inherent problems have been identified with this practice:

- * it is costly and time-consuming to train teachers to be programmers.
- * the quality of software so produced is often unsatisfactory.

c) Quality Control

Little or no control is being exercised over the quality of software. China seems to be the only country to have a quality control mechanism at the national level. Teachers need help with the evaluation of software, as they are often subjected to sales pressure from manufacturers. The evaluation of software is also a time-consuming process for teachers. Australia offers a useful framework for such evaluation.

d) Dissemination

No systematic means of information dissemination on the availability, quality and possible classroom use of existing software exists in many countries. This can also be inferred from the IEA countries, where in some cases more than 60% of the schools report a lack of information about software as one of the major problems. A national on-line data base of software information would be invaluable for schools. Such information could also be disseminated through published materials.

e) Costs

It is generally accepted that high costs of software production have been a major inhibiting factor in large scale software generation and distribution.

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f) Language Problems

Acute difficulty is experienced by countries which have languages other than English as the medium of instruction. They are unable to use available commercial software and in most instances locally produced software is not yet available. Efforts to produce software in the local languages have not, on the whole, met with much success. A particular difficulty is experienced by a country such as India which has many languages of instruction.

g) Copyright Issues

The copyright laws in some countries are strictly enforced. Other countries do not have copyright laws. If no form of copyright protection exists, it is difficult to encourage the educational software industry.

D. TEACHER DEVELOPMENT

Most countries have made considerable efforts in the area of pre-service and in-service training of teachers in the use of computers and their integration into education. Despite this, almost every country suffers from a lack of adequately trained teachers. The IEA study also shows that there is a pressing need for training in most countries, although it may be a promising sign to note that this need declines with increasing years of experience in using computers. In some countries government support is provided for the in-service training of teachers but this training is optional in some countries. Commercial house may also sponsor the training of teachers. It is clear that more comprehensive courses need to be designed, and far greater support needs to be provided by advisory/resource personnel for teachers in their classrooms.

In the early stages of computer use it seems to be mostly teachers of science and mathematics who have been involved in training courses as well as in the actual use of computers in the classroom. However, as the use of computers in education progresses, teachers from other subject areas become involved.

Teachers are often apprehensive about the use of new technology in their classrooms. However, the IEA data show that in most countries teachers seem to be interested in using computers. Moreover, this interest seems to have operated as a major catalyst for introducing computers in schools. In developed countries, where children frequently have access to computers at home, students are often more familiar with computers than their classroom teachers.

E. GENERAL

a) Financial Constraints

A major constraint in the large scale introduction and implementation of a programme for the use of computers in education is the paucity of

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funds. It is an extremely costly endeavour as it involves a major capital outlay for resources, which must include on-going funding for maintenance and the future up-grading of machines, as well as training and support.

b) Evaluation and Monitoring

Not all countries have conducted systematic evaluation studies or devised in-built mechanisms for evaluation and monitoring. Those studies which have been carried out have been costly and it has taken a long time to publish results. Most of the problems which have been identified by participating countries have been clearly described in existing evaluation/research studies. Japan has carried out very extensive research into the implementation and use of computers in education. This research has been initiated and supported by the government.

As many countries are investing large sums out of already scarce resources it is imperative that feed-back relating to outcomes should be available to governments as well as to educators.

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- Becker, H. J. (1990) *Computer use in United States Schools: 1989*. An Initial Report of U.S. Participation in the I.E.A. Computers in Education Survey.
- Pelgrum, W. J.; Plomp, T. (1990) *Introduction of Computers in Education: State of the Art in Ten Countries*. Paper presented at the convention of the American Educational Research Association, Boston, MA, 16-20 April 1990.

Chapter 3: Problems, Issues and Suggested Strategies

I : Policies, Goals, and Objectives

A. Goals

As information technology permeates every aspect of life in most societies, many governments have begun to see the need to formulate strategies to introduce computer literacy to the masses of children in schools. However, the introduction of computers in education is a complex innovation that requires careful consideration. Main factors such as national context, funding requirements and support structures for schools and teachers should be carefully considered in order to develop realistic goals for using computers in education. It is clear from the discussion among participating countries that the goals for the use of computers in education fall into the following categories:

- a) To improve educational achievements by integrating this new technology into the curriculum.
- b) To prepare students for careers in an information oriented society.
- c) To increase the efficiency of educational administration.

B. Problems and Issues

The following were identified as problems affecting policy-making with regard to the use of computers in education:

- a) Lack of a strong desire by policy makers to hasten the use of computers in education when there are competing demands for available resources. Conflicting perceptions of what computers should and will do for students and society further impedes policy-making in the use of computers in education.
- b) Lack of research studies on the effectiveness of the use of computers in education. Most meta analyses are based on data which may not necessarily be comparable with conditions in countries of the region.
- c) Lack of funds, especially in developing countries.
- d) Lack of additional resources such as space, electricity, and furniture.
- e) Perceived overcrowding of curriculum may also be an inhibiting factor.
- f) Lack of systematic training of teachers in the effective use of computers in education by teacher-training institutes.

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C. Trends

- a) While all countries recognize the need for computer awareness either through the formal curriculum or as an extra-curricular activity, they vary in the degree of emphasis on the objectives of the use of computers in education. The trend is, however, towards the increased use of computers in learning.
- b) Most of the participating countries are still concerned with vocational needs and hence emphasize computer studies. The trend, however, appears to be away from programming of computers and towards their applications.
- c) Some countries are increasingly incorporating generic software such as word processing and spreadsheet into their subject teaching. In others, 'learning through computers' by the use of CAI software is a major trend.

D. Strategies

- a) The economic, educational, social and political context of each of the countries is very different. The policy for the implementation of computers in education in any one country must take these aspects into account, but it should also consider the ways in which other countries have made the use of computers in education effective.
- b) Whenever possible, the implementation of computers in education programmes should be monitored initially through pilot programmes. As less money is involved, it is easier for policy makers to approve pilot programmes. The results of pilot programmes may well convince policy makers of the need to introduce an extended programme.
- c) The implementation of computers in education should be phased in gradually for practical reasons. This will also enable teachers to have time to effectively assimilate the new technology into their teaching or school administration.
- d) Research findings should influence strategies for the affective use of computers. The efficacy of these findings could be tested through pilot projects.
- e) Countries should develop working policy statements which should include references to hardware, software and teacher development. This will facilitate the use of computers in education.

II : Hardware

The following problems, issues and possible strategies for dealing with these have been identified in the area of hardware.

1. Lack of clearly written guidelines on specification and configurations

Hardware specifications should include the following dimensions:

- 1.1 physical capabilities such as robustness, easy connection to peripherals, ergonomic design, equipment portability, built-in communication capabilities and provision for future expansion.
- 1.2 capability for applying educational software/courseware such as graphics, colors, sound and user friendliness suitable for the level of the students operating the machines.
- 1.3 availability of peripherals such as printers, mouse, touch sensitive boards and screens, and special options for the handicapped (such as, remote control devices and adapted keyboards).

2. Not enough computers for instructional use

The number of computers needed per school depends on the goals pursued and the type of applications used. For instance, learning about computers can take place with whole classes of students in a computer laboratory.

Other types of applications such as drill and practice, tutorials, simulations and modeling, generic tools such as a word processor or spreadsheets may be used by individuals or small groups. This assumes a link with existing lesson practice and the availability of computers in classrooms.

Instructional goals, expected effects and associated costs should be carefully weighed in deciding on an adequate number of computers, especially as the availability of quality software and courseware is still insufficient.

3. Uncertainty about where to locate computers

Decision on whether to put computers in classrooms or laboratories should be based on a clear understanding of the purpose of instruction/learning (see Problem 2). International assessment data shows that as the availability of computers grows, more of them are located in the classrooms (Plomp & Pelgrum, in press).

4. Lack of understanding of the relative advantages and disadvantages of standardisation

- 4.1 Standardisation may be achieved in three ways: by choosing the computer system (e.g. IBM-compatible 16-bits, etc.), by operating systems (e.g. MS-DOS), or by a combination of the two. The decision-makers should be aware of the advantages and disadvantages of standardisation by either form.

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- 4.2 When standardisation is by computer system, user familiarization with hardware, ease of networking, and retraining of teachers can be advantageous. The possibility that the vendor may dominate or that unforeseen faults in the chosen machine may emerge, could impede the adoption of new technologies.
- 4.3 Standardisation by operating system enhances the possibilities for exchanging software and provides easy access to a greater range of software, while incompatibility with other operating systems can be a disadvantage.
- 4.4 As it seems advisable to standardize both on a computer system and an operating system, a major consideration should be given to minimum standard specifications (e.g. processor, memory and monitor quality) so that future developments can be taken into account.

5. Lack of adequate provisions for maintenance

In order to ensure a good maintenance system, there should be a suitable contract with vendors whose responsibilities should be clearly stated. These should include provision of technical support and basic initial training for operation and maintenance.

III : Software/Courseware

The following problems, issues and possible strategies for dealing with these problems have been identified in the area of software/courseware.

1. Lack of software/courseware

- 1.1 There is a need to design a strategy for the development and dissemination of software. This should take into account all factors essential for the successful implementation of educational innovations.
- 1.2 Software development sources should be identified and activated.
- 1.3 Educators need to identify and prioritize areas within the curriculum in which to develop appropriate software and courseware.
- 1.4 In order to minimise the problems of software development, educators should identify already available generic tools as well as content-specific software. This may include not only local resources but also those of other countries. The cost of production should be weighed against the cost of adaptation of existing materials.
- 1.5 The educational impact of interactive video-disc has already been successfully tried in advanced countries. Educators may wish to consider this in future.

Chapter 3: Problems, Issues and Suggested Strategies

- 1.6 In order to disseminate software in an effective way, there is a need to set up an on-line data-base at local, national and/or regional level.
- 1.7 There should be a mechanism to catalogue all available software and distribute this information among schools and local educational authorities.
- 1.8 Educational critiques of software/courseware should comment on its quality in terms of relevance to the topic, accuracy of content, user friendliness, available support materials, screen design features and ease of use.
- 1.9 Special interest groups can be formed for the exchange of information.

2. Lack of exploitation of computer capabilities

Currently, computer capabilities are not completely explored in education because most countries still use drill-and-practice applications. More sophisticated forms of computer use such as simulation and modeling which are geared towards high level cognitive objectives, and the use of generic tool software should be investigated and applied as appropriate to each country.

3. Lack of support materials

To gain the maximum benefit from software, support materials for teachers and students could be provided in a range of different media. Possible topics would include:

- * lesson preparation,
- * class management,
- * integration of the use of computers in the existing curriculum.

4. Lack of user-friendliness

- 4.1 Software designed for education should be easy for students and teachers to use.
- 4.2 Often students may wish to exit from a programme before they have completed it. In order that they may use materials without frustration, software should be flexible enough to allow them to exit or enter at any point in the programme.

5. Lack of evaluation criteria

Except where software is produced by government agencies, there is seldom an effective quality control mechanism. To ensure that educational institutions purchase only good software, a framework of evaluation criteria

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should be constructed.

IV: Teacher Development

The following problems, issues and corresponding strategies were identified by the participants:

1. **Lack of a realistic, practical, achievable and coordinated policy or plan for a teacher/staff development programme in the use of computers in education at the school level**

There should be a realistic, practical, achievable and coordinated national and local plan on teacher/staff development. This should be implemented, monitored and periodically evaluated and revised.

2. **Teachers lack knowledge, skills and confidence to integrate the use of computers in schools**

- 2.1 There should be a pre-service teacher training programme on the use of computers within the existing curriculum of the country.

- 2.2 Teachers should be able to identify, evaluate and incorporate suitable software for use in learning, teaching and class-room management. In-service teacher training programmes should include the use of computers as productivity tools. Such training programmes should also include the actual use of information technology tools and multi-media equipment.

3. **Lack of coordination and leadership in the use of computers in schools**

- 3.1 A coordinator responsible for the use of computers in education should be designated in schools.

- 3.2 The computer coordinator should have special training and expertise on the use of computers in education.

- 3.3 The coordinator should be provided with the resources needed to carry out the task.

- 3.4 A component of the task of the coordinator should be to impart his/her computer skills to other teachers.

4. **Teachers find it difficult to cope with the rapid developments in information technology and in knowing how to apply these to the use of computers in education**

- 4.1 There should be information dissemination programmes both at school and national levels.

- 4.2 Opportunities should be provided for teachers to upgrade their

Chapter 3: Problems, Issues and Suggested Strategies

skills through seminars, workshops and training on use of computers in education.

- 4.3 Special interest groups on the use of computers in education should be formed.
 - 4.4 Teachers should be encouraged to join professional associations involved in the use of computers in education.
 - 4.5 An industry-education cooperation programme should be instituted.
 - 4.6 There should be sharing of resources and experiences among schools through linkages, consortiums or tie-ups.
5. Lack of incentives for teachers to acquire needed skills, to use these skills in classrooms and to remain in school after training
- 5.1 Due recognition should be given to the role of the school coordinator.
 - 5.2 Teachers should be convinced of the need to integrate the use of computers in the curriculum.
 - 5.3 Opportunities for promotion should be made available to computer coordinators.
 - 5.4 Teachers who were given special training should be bound to serve for an adequate period of time after completion of their course.

V : On-going Support of Teachers

Participating countries indicated that there is a lack of on-going support to ensure success in using computers in schools. The following strategies were proposed:

1. There should be an information dissemination programme about hardware/software evaluations and acquisitions and the latest developments and trends through newsletters, journals and the like.
2. Provision should be made for teachers to attend seminars, conferences, workshops and training for updating their knowledge and skills in the use of computers for instructional purposes.
3. There should be a coordinating body to provide logistical support and consultative services at a national, regional and local level.

VI : Research and Development

Participants reported that there is a lack of research and develop-

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ment initiatives in their countries due to lack of policy and programmes, funding, and expertise. The following strategies were enumerated:

1. School administrators and governments should devise a research and development policy on the uses of computers in education.
2. Research and development projects on the use of computers in education may be initiated by private and government agencies at the national, regional or local level.
3. Research in the following areas should be conducted:
 - * The costs and benefits of the use of computers in schools.
 - * The resources needed to introduce and sustain the use of computers in schools.
 - * The development of educational software.
 - * The effect of computer use on student performance.
 - * The approaches to the implementation of an effective programme on the utilization of computers in schools.
4. Teacher training programmes should include instruction in the interpretation of educational research.
5. Countries should share research findings and experiences through formal and informal linkages.
6. Additional research funding through international and regional institutions, multi-national companies, private and business sources may be explored.

Chapter 4: Recommendations

A: Policy

The Seminar concluded that many countries are in the process of introducing computers in education. Most countries seem to pass through similar stages in adopting and implementing this technology and seem to be struggling with the same kind of problems. This innovation is a very complex one, requiring many changes in educational practice. A general conclusion was that most countries did not pay sufficient attention to all essential factors when developing an implementation strategy.

In view of this, the participants recommend:

- that countries formulate policy which clearly spells out their commitment to the introduction and integration of computers across all levels of education. Depending upon the availability of resources, clear goals and objectives should be set for each stage of an incrementally phased implementation programme.

A policy document on the use of computers in education should include:

- the intended purpose for which computers should be used in schools;
- their place in the existing curriculum;
- a focus on teacher development;
- the provision of on-going support for teachers;
- a mechanism for the maintenance, repair and replacement of hardware;
- a mechanism for information dissemination;
- evaluation and monitoring strategies to determine the efficacy of the programme; and
- provision for a coordinating body to oversee the implementation of the programme.

B: Hardware

Previous experience in many countries shows that the choice of hardware is of crucial importance in the realisation of the goals of a computers in education policy.

Although financial constraints inevitably determine the extent of the provision of hardware, choice of operating system and hardware should always be made on educational grounds.

C: Software

As software development is expensive, and as the software chosen will have a profound impact on the classroom programme, it is recommended:

- that existing resources are evaluated prior to embarking on software development.
- that educational impact should be examined to determine whether educational goals have been attained.
- that evaluation guidelines for the quality of software and its relevance to the existing curriculum should be developed.
- that countries developing educational software should examine the software of other countries with a similar context, so that each may benefit from the software production of the others. They may also be able to adopt similar techniques of software production, allowing mutual accessibility.

D: Teacher Development

Experience shows that initial and on-going teacher development is of crucial importance to the successful implementation of a computers-in-education programme. It is therefore recommended:

- that tertiary institutes should be encouraged to provide pre-service training for teachers in the use of computers in education.
- that on-going in-service training and classroom support should be provided for teachers.

Any educational innovation, to be successfully implemented and to bring about the intended impact, requires the active participation of teachers. Therefore, in-service training and the provision of on-going support will motivate teachers to introduce and implement computers in education.

Both in-service and pre-service teacher training, including the information on the possible advantages and outcomes of application of computers, as well as actual skill training in the handling and management of hardware and software is recommended.

E: Research and Development

In the interest of accountability and in order that informed decisions should be made about future implementation strategies, it is recommended:

- that mechanisms for monitoring progress and evaluating outcomes should be an intrinsic component of a computers in education programme.

- that every effort should be made to encourage research into different aspects of computer use in schools.

F: General

Each country has recognised the importance of the role of computer coordinators in schools. It is therefore recommended:

- that some recognition should be given to school computer coordinators in terms of status and/or financial considerations.

It is essential that educational administrators understand the educational objectives and management strategies of computers in education. Accordingly it is recommended:

- that courses specifically designed to inform educational administrators be implemented.

Where computers are to be used in the administration of schools, effective use by the administrators is essential. It is recommended:

- that educational administrators receive effective, on-going training in the use of educational administration software.

International exchange of information has proved to be very useful in helping countries to understand their own situations and to identify possible ways of resolving problems. The ways in which international assessment studies have been conducted (especially those performed by the IEA) combined with workshops and seminars of participants seem to promote a better understanding of the implementation of computers in education.

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Participants

- | | |
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Appendix B: Country Reports

Australia

"Introducing computers into schools may change them, but under what conditions dose it improve them?" (Bigum et al, 1987, p.302)

This question was posed at the end of an extensive evaluation of computer use in Australian schools in 1987. At that time it was clear that the answer was not known. This paper will attempt to re-examine the question by looking at historical and present perspectives, problems, issues and trends.

HISTORICAL PERSPECTIVE

In 1984 a budget of A\$18 million was allocated to fund the first *National Computer Education Program* in computer education in Australia. Although the initial impetus and base funding for this venture came from the Commonwealth Government, individual States made, and are continuing to make in successive programs, significant contributions from their own sources. Substantial support funds have also emanated from parent bodies. In this way initiatives have become a joint venture between Central and State Governments with frequent support from parent bodies.

In 1987 the Deakin Institute for Studies in Education published an extensive evaluation of the project, entitled *Coming to Terms with Computers in Schools - a Report for the Schools Studies of the National Computer Education Program*. This report suggested that the use of computers in schools was bringing about significant educational change. It focussed on changes in the language and communication of the school community, in school organisational structures and in curriculum innovation. It noted the healthy mix of initiatives springing from the range of States, schools, teachers and subject associations which had resulted in the use of a diverse range of machines for a variety of different purposes. It also commented on the gradual shift in emphasis from computer-assisted instruction, such as drill and practice, to more open-ended uses of the computer as a specific-purpose tool.

CURRENT PERSPECTIVE

1. Numbers of Computers

The ratio of computers to students is increasing, but still falls far short of the OECD standard of one computer to ten students. The average ratio of computers to students is fifty students to one computer in primary schools (slightly better than one computer between two classes) and a minimum of one-to-forty in secondary schools. The ratio of computers to students varies widely between individual schools. Some schools have already reached the target of one computer to ten students. In one Queensland school sixty students have been given individual lap-top computers in an experiment which will be carefully monitored over several years to determine the effect on their learning.

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Although it would be advantageous to have more computers in schools, a ratio of one computer between two classes need not be inhibiting. With co-operative time-tabling it has been possible to share a computer profitably between two classes. Schools have found that within an individual class one computer can be used to great effect by rotating small groups through a variety of learning activities. In this way the computer becomes the focus of small group interaction.

In secondary schools where the focus for computer use has historically been learning about computers, most computers are aggregated in laboratories. There is, however, a growing trend for subject departments to acquire their own systems.

2. Using Computers as Teaching/Learning Tools

The use of computers by teachers and students to enhance learning across the curriculum is encouraged by all States. Many recent syllabus documents promote the use of computers to ensure that students address problems which are specially susceptible to technological solutions. Older documents tend to mention computers and technology only as an after-thought.

3. Computer Use in Secondary Schools

The following categories provide a framework for computer use:

- Learning about computers: Some students learn the basic principles of computing, examining the social and environmental implications and consequences of technology in society.
- Learning with computers: Students use computers and allied technologies to enhance and extend their education in the subject areas. As they achieve educational goals they also extend their computing skills and competencies in a meaningful context.
- Learning through computers: Students use computers to solve problems and to meet specific challenges across a wide range of applications.

Applied computing courses are very popular in secondary schools. These are linked to specific career opportunities such as Business Education, Accounting, and Computer Assisted Design.

4. Computer use in Primary schools

It is not felt to be appropriate or desirable for children of primary school age to spend time learning about computers. The emphasis for this group is placed on using computers as tools for learning. Today's children are not afraid of technology and quickly come to terms with computer use as they meet different applications across the curriculum. They learn about computers best through using them in a variety of relevant contexts. This

is why most State education authorities discourage the use of computer laboratories in primary schools. With a well designed program of learning experiences they should cover the range of desirable skills through direct, hands-on experience.

5. Computer use in Special Education

Computers are used in special education to enhance learning. They play a vital in enabling physically and intellectually handicapped students to have greater access to education through activities similar to those enjoyed in the regular classroom. For many students who are paralysed or unable to talk, computers also provide an essential, and sometimes the only, means of communication. Equipment used by these students can be costly to purchase, to install and to maintain, but much can be accomplished with relatively simple devices and imagination. It is considered essential that handicapped students have access to appropriate technological aids.

6. Computer Use in Distance Education

Computer technology has brought significant changes to the delivery of education to students in remote areas. Satellite communication and lap-top computers are likely to continue to revolutionise distance education. The needs of isolated students on remote stations in the outback have driven educators to experiment with different and innovative modes of delivery. Some of these are electronic voice/date/video communications, electronic blackboards, interactive TV broadcasting, FM sub-carrier radio, loudspeaker telephone terminals, facsimile machines and beamed microwave links. In Tasmania 90% of all schools are linked electronically through TASNET to facilitate the dissemination of curriculum materials. Keylink, a national telecommunications system is being used in New South Wales, Victoria and Western Australia. Queensland has made extensive use of satellite links and leads the way in this field. In South Australia the DUCT system links remote schools with those in the metropolitan areas. A Victorian Rural Communications Technology Project enables teachers to teach students in three or four other schools simultaneously which are linked to their own classrooms. The Northern Territory has made extensive and fruitful use of computers in its schools of the air. Many of these initiatives, created to meet the needs of remote students, have the potential to inform educational thinking and operations in city schools in the future.

7. The Use of Computers with Interactive Video-link to Facilitate Teaching, Learning and Teacher Development in Remote Areas

Some States have explored this field very profitably and have set up links which are both time- and cost-effective. Not only does this use of technology enhance the education of great numbers of students, but it reduces the inequities experienced by students and teachers in remote areas. Using computers with an interactive video-link, for instance, one piano teacher in New South Wales is able to meet the needs of six secondary schools scattered over the State. In remote districts the initial financial outlay is soon recovered as teachers gain access to professional

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development without leaving their home schools. This obviates the need to fly experts into a central venue and transport and accommodate teachers from remote areas.

PROBLEMS

General

- The current generation of teachers has not been brought up with computers. More students than teachers use computers in their homes. Many teachers not only lack confidence but also do not fully understand the potential of computers in the classroom.
- Often the hardware children have at home is superior to that at school, or is not compatible.
- If a member of staff is skilled in computer use, then that teacher is given charge of computers throughout the school, often in a laboratory situation. This usually means that other teachers are able to abrogate their responsibility because the school lacks a comprehensive plan for their professional development and the phasing out of the laboratory. Students are then disadvantaged as computer use does not become an intrinsic part of their daily programme.
- There is still inequity of computer use between the sexes. In primary schools this can arise from an imbalance in the choice of software and computer activities which are not equally appealing to both sexes. In secondary schools computer studies are optional. Girls tend not to take this option. An "across the curriculum" approach would minimise this inequity.

In Secondary Education

- There is a shortage of qualified teachers to take advanced computer-studies courses. This stems in part from the opportunities for computer graduates in commerce and industry where there is a similar shortage. The lack of career opportunities for computer teachers does not make this a rewarding path to follow.
- There are insufficient teachers with computer experience to take general computing studies.
- The traditional "laboratory" approach inhibits use of computers across the curriculum.
- Computer use is still not sufficiently valued or used by secondary teachers in their subject areas.

In Primary Education

- Newly graduated teachers are generally inadequately trained or a

quainted with computer use across the curriculum.

- Some parents, principals and teachers do not understand the rationale behind computer use in primary schools and therefore persist in retaining a laboratory approach.
- Teachers often fail to apply the same rigorous standards to their choice of software as they would to other educational materials.

ISSUES

Student competency outstripping course content

Increasing use of computers in the home and in primary schools means that students are entering secondary education as competent computer users. Many of the old style computer awareness courses are now out of date and are being reviewed.

Lack of co-ordination between secondary and tertiary courses

There is sometimes a degree of tension between school- and university-based computer studies courses. Many tertiary institutes question the need for advanced computer studies at school as a prerequisite to tertiary admission. It is questionable whether such highly specialised school courses are appropriate in the context of a general education.

Quality of educational software

There is growing dissatisfaction with trivial software which may offer clever attractive graphics but is limited in its capacity to help students achieve educational objectives. Unfortunately such software provides an easy starting point as teachers can use it without disturbing the traditional curriculum or their traditional teaching style. Unless there is a commitment to move to a more challenging type of software, teachers become disillusioned and feel that computers add little to the curriculum.

The quality of the software used can exploit or negate the intrinsic advantages of computers. Schools invest valuable resource money in software. It is vital that educators use clear criteria in the evaluation of software. Teachers need to ask:

- WHY use this program?
 - Are the educational objectives clear?
 - Will it achieve what it says it will?
 - Is the content accurate, appropriate, interesting and relevant?
 - Do the accompanying materials extend the students' educational experience?
- HOW is it enabling students to function as learners?
 - Does the program design enable child control within clearly defined parameters?

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- Are planning, problem-solving, decision-making and variable manipulation central?
- Can the program be used interactively with groups of students, encouraging discussion and the cooperative working out of solutions?

WHAT are students learning that they could not learn equally well another way?

- Does the software exploit the unique attributes of the computer to achieve the objectives?
- Does it offer an additional, alternative or more efficient route to the achievement of the objectives?
- Would it be just as effective to use a traditional medium?
- Are students able to exercise skills normally thought beyond their capacity in order to explore concepts which are being developed?
- Does the use of the software require students to develop a new way of thinking or different strategies which will achieve better outcomes than traditional methods?

Parental understanding of educational computer use

Parental concern that students should have access to computers in schools is grounded in the belief that familiarity with computers will enhance their children's future work prospects. Parents wishing to give their children the best possible start in life often buy a computer for home use. It is evident, however, that many parents do not understand the rationale for computer use in education and so the computer becomes little more than an expensive toy. It is crucially important that parents and schools share clear understandings about the purpose and nature of computer use in education and that parents become aware that such usage will meet both parental objectives and general curriculum objectives.

Differences between schools

There is a wide gulf between a minority of schools which are working at the cutting edge of computer use in education and the majority which are still using computers as teaching machines, typewriters or toys.

The Western Australian policy document *Computer Use in Primary Education* maps the development of expertise in computer use along a continuum. This not only helps teachers to identify desirable goals, but helps them to recognise the small steps they can take as they move forward towards each goal.

TRENDS

The use of generic software across the curriculum

Word processing is now widely used in schools to enable students to write reports, newsletters and any other form of text. Desk-top publishing

is useful when class newspapers or school magazine are being produced. Different scripts can be used for mathematics, music and languages other than English.

Students carry out research and then construct their own data bases. This helps them to develop skills of classifying, recording and retrieving information in the context of inquiry learning. Spreadsheets enable them to deal with numerical data. A wide variety of graphics packages assist students to design and represent ideas effectively. Music packages give many students access to a world that they might never have penetrated without this software as do graphics package in art/craft.

The use of such generic software can only lead to the enhancement of students skills and to increased understanding about the power, versatility and usefulness of computers in everyday life, industry and commerce.

The use of communications software and interactive video links

The potential in this field for national and international communication and interchange can only continue to expand. Many schools in Australia participate in the Epson Computer Pals project and have participated in the Trans-Antarctic Expedition and the Around the World Yacht Race and a schools linkup with students in Moscow.

Computer use with disadvantaged children

Work has been taking place which shows clearly that computers can be used to great advantage with children who are educationally disadvantaged by reason of language, low socio-economic status or cultural difference. A Commonwealth *Project of National Significance* was undertaken in 1988 to explore the use of computer-based technologies by disadvantaged groups of Children. A report, entitled *Computers and the Realm of Ideas - An Interim Report on the Involvement of Disadvantaged Children with Computers* published by the Commonwealth Schools Commission, delineates a range of different ways in which computers have been successfully used in classrooms across Australia to combat educational inequality.

Much has already been accomplished in this areas, but much more remains to be done. In Western Australia significant advances are being made in the early literacy learning of disadvantaged children using touch-sensitive boards. Work is also currently underway using this powerful aid in the teaching of Aboriginal languages. Another area in which progress is being made is in early mathematics learning. It is essential that this work be carried forward as it will not only help the disadvantaged, but it has many implications for mainstream education.

Technology education

Computers have also been used in the broader context of technology education. The *National K-12 Technology Curriculum Mapping Project*, set up in late 1989, will bring a measure of coherence to the use of computers

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across the country.

Tasmania is developing a K-12 technology framework which will bring continuity to teaching and learning across year levels. The aim is to promote critical, creative and imaginative thinking and to provide links with local industries and communities. In South Australia the technology syllabus is underpinned by a set of attainment targets which provide examples of exemplary practice and facilitate monitoring and assessment. Strategies for implementing change are offered together with indicators which can be used to monitor progress. In Western Australia work is being carried out on a major design technology curriculum component which is building on international trends and developments in design education. Advances are being made through Applied Technology courses in both lower and upper secondary school. These encompass industry links, work experience and enterprise programmes.

Technology high schools, which place a specific focus on the development of technology-oriented partnerships between education and employers, are proving to be very successful. In New South Wales, IBM has given 1 million towards the setting up of a custom-built school. This school, due to open in 1992, will be the first specifically designed to promote technology.

The compilation and use of national data-bases

The Camoco Projects Inc. data-base of curriculum objectives for special educators has been operating successfully for two years. Australian Schools Catalogue and Information Service offers the National Software Co-ordination Unit Software Review Database which includes summarised reviews from a variety of sources.

The use of computers to automate school libraries

An automated Library data-base has considerable benefits for teachers and students, as it:

- offers educational opportunities for students to develop information skills using a dynamic, relevant data-base - the library catalogue;
- develops awareness of data-base applications for information retrieval in business and industry;
- optimises access to the use of information resources in the school; and
- provides access to online national data-bases.

In addition school libraries are investing in C.D. Rom technology. Access to such resources as the Oxford English Dictionary, Guinness Disc of Records and several encyclopedias can now be provided on line. These ventures have demonstrated the viability, cost-effectiveness and importance of rendering such information accessible to all teachers in Australia.

Administrative computing systems for schools

Computer systems which revolutionise school administration are now in common use. Academic records, student numbers, timetables and financial records are all now computerized, saving hours of administrative time. Not only is data collection easier, but information is readily accessible and may be transferred between schools and central offices at will. The installation of these systems has been undertaken in conjunction with extensive training which has ensured that the transition from the old system to the new has occurred smoothly and efficiently.

Use of computers by teachers

Teachers are increasingly taking advantage of the opportunities offered to use computers as personal tools in the preparation and delivery of lessons and in report writing. They are also using, desktop publishing and electronic mail with increasing facility. This is heightening their awareness of the nature and potential of computers to improve student outcomes. Teachers who are reluctant to use computers in their classrooms can be encouraged to do so by discovering the power of a computer to lighten their workload.

CONCLUSION

As students use computers in school to accomplish a vast range of tasks:

- they begin to comprehend the power and range of computers as problem-solving, information processing and communicative tools which can be used effectively in many situations; and
- they are able to extend and enhance their skills and understandings in literacy, numeracy, science, social studies, art, music and in all subject areas which form the basis of a sound and liberal education.

As educators use computers in schools:

- they are able to carry out their administrative duties with increased efficiency; and
- they are able to use the unique attributes of computers to cross the frontiers of teaching and learning.

Australian schools have made a great deal of progress in the last decade as computers have become more widely used and their capabilities have been creatively applied to enhance children's educational experience. It is in this decade that we must ensure that further applications are explored, innovations consolidated, trivial uses of computers rejected and sound educational objectives achieved.

The Deakin Report assumed that the introduction of computers into

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schools was bringing about change. It posed the question:

"Introducing computers into schools may change them, but under what conditions does it improve them?"

The passage of time seems to show that the introduction of computers may not, in fact, change schools at all. It is quite possible to subsume new technology into old philosophies and practice. Drill and practice remains drill and practice whether it is carried out by chanting mathematical tables or pushing buttons on a keyboard. If children are subjected to tutorial programs which simply require them to make a yes or no response they do not need to think for themselves at all. Rotating classes of students into computer rooms where they learn to type does not change the fact of education. Using computers as rewards for good work will not add anything different to a teacher's program.

The conditions which give rise to positive change in the educational environment and in student outcomes spring from the vision of the educator. Computers change schools for the better when their use is underpinned by sound, sensitive and creative educational thinking. It is when technology is harnessed to facilitate the learning of language and mathematics, to break down the isolation of remote schools, to improve the educational opportunities of cultural minorities and to empower students in their work that schools are, in fact, changed for the better.

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Brunei Darussalam

Introduction

In 1983, new BBC computers were placed into most government secondary schools. Each school was equipped with at least four computers complete with disc drive, high graphic colour monitor and printers. Another 2 units of BBC computers and a printer were supplied to all secondary schools in 1987/1988. About the same time when the four computers were placed into secondary schools (i.e. 1983), a computer resource centre was set up at the Sultan Hassanah Bolkiah Teachers Training Centre and copies of nearly all available software and books were purchased and made available to teachers. Courses were conducted regularly to promote the use of computers in education and generally computer appreciation clubs were flourishing.

Now the Computer Resource Center is relocated at the Extra Curriculum Activity (ECA) Unit due to the merging of the Teachers Training College with the University of Brunei Darussalam.

Introducing computer education into the school curriculum and implementing computer education as a new subject in secondary schools had been envisaged in the Ministry of Education for a number of years. In 1986, one of the secondary schools introduced computer studies which prepared students for the 'O' level Cambridge Overseas School Certificate Examination. There were about 14 secondary IV students taking this option subject. At present, the computer subject is not offered to secondary students due to some constraints such as lack of qualified and experienced teachers, and insufficient resources. In the meantime school computer appreciation clubs are encouraged to play both a complimentary and supplementary role.

The comments on this paper are confined to government schools and higher institutions only. It is noted, however, that various private schools at both primary and secondary levels have now started to use computer both for ECA activities and in the classroom.

The Use of Computers in Education

1. Computer Appreciation Clubs

1.1 Secondary Computer Appreciation Clubs

Computer Appreciation Club in secondary schools are offered only to selected students due to limited number of computers and lack of qualified computer teachers. The club is part of the school's Extra Curriculum Activities (ECA) which run outside school hours.

The lack of resources and the heavy teaching load of the teachers with responsibility for school computers is often blamed for the lack of computer appreciation clubs. The repair servicing of computer is unsatisfactory. It is proposed that it would be best to offer a contract out to tender.

In 1989, the ECA Resource Center managed to purchase some computer software. Teachers who are running computer appreciation clubs are now

beginning to realise that the software stocks being built up by the computer section at ECA provide many opportunities for exploring a number of useful activities and so are now taking advantage of this availability of software. In previous years there was little or no suitable software available to schools, but the use of the BBC Syndicate software has now improved the ability of schools to offer successful and exciting computer appreciation clubs.

To supplement their clubs' activities some schools made educational visits to places where computers are used extensively, such as the Brunei Shell, the Economic Planning Unit and the Computer Section in the Ministry of Finance, and the Computer Section of the Public Service Commission.

1.2 Primary Computer Appreciation Club

Primary schools have been invited to send pupils for weekly sessions on the Resource Centre Computers.

The computer appreciation club lasts for a minimum of 5 weeks and a maximum of 8 weeks. The activities of the clubs cover a wide range of topics, such as computer music, computer art, primary mathematics, computer adventures, desk top publishing, computer speech and other across-the-curriculum computer applications. All pupils attending the clubs are awarded a certificate detailing the activities in which they participated.

Generally the aim of the club is to provide children with the necessary skills and confidence to operate computer and to provide opportunities for them to use a computer package.

In many ways this has been the most successful venture undertaken by the computer section. It revealed the need for further use of computer at all levels of schooling. Teachers who attended have become aware of the use of computers in the primary classroom.

1.3 Computer Appreciation Courses

Now that the ECA computer room has been improved, it is far more suitable for running computer courses. Courses for secondary teachers took place in one of the secondary schools early this year. The course consisted of two hour session once per week for a total of six weeks.

The aim of the computer course is to encourage teachers to become confident computer operators and to provide the necessary skills they would need to run computer appreciation clubs in their schools.

A similar course is offered to teachers in primary schools and is currently being run at the ECA Unit Computer Resource Room.

2. Computer in the Classroom

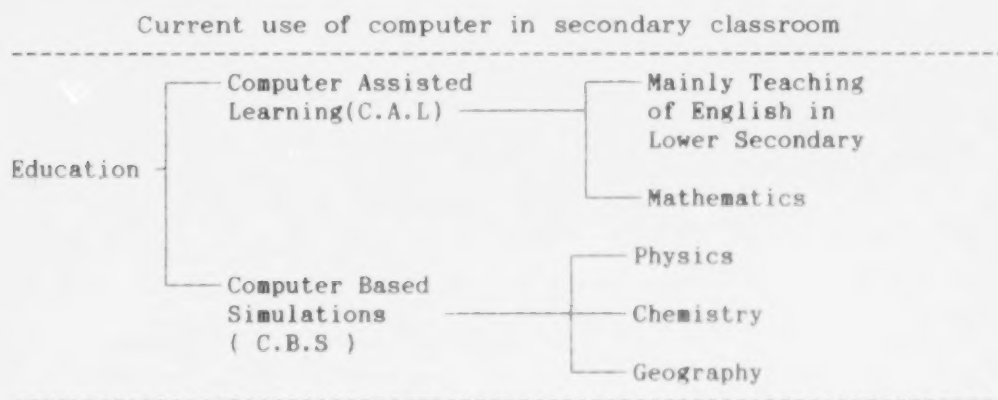
Teachers have not all been trained to use the computers but some

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capable and determined teachers found a means of using the small number of computers with their students.

Teachers of Mathematics in various schools and teachers of English, from the Centre For British Teachers (CFBT) in particular, have been very active in this areas. Interest in the use of computers in other subjects is now beginning to grow as teachers become aware of the subject software available at the ECA Resource Centre.

A one-day seminar on the use of computers in teaching English was run at the ECA Centre in response to a request from the Centre for British Teachers.



3. Software Development

The Statistics/Computer Section, Department of planning, Development and Research, with the help of the Computer Section in the Ministry of Finance has developed an educational statistics software packages. Two units of computers will be supplied to this Department. Due to lack of computer experts in the Department, there is no point in the Treasury Department supplying a Mini Computer yet.

There is also some software development taking place in certain schools primary to reduce the chore of doing repetitive administrative tasks undertaken by teachers, and to streamline the returns of statistics or other information from individual teachers to the school-management.

4. Computer in Tertiary/Higher Institutions

The Saiful Rijal Technical College offers a one year course leading to a Certificate of Computer Programming and a one-and-a-half year City and Guilds Computer Programming and Information Processing course.

The Higher National Diploma (HND) for computer studies which runs for two-and-a-half year is offered to students by the Institute Technology Brunei (ITB). The intake for the first batch was in 1985. This year the 4th intake is about to complete the course. There were about 20 to 25 students

in each intake. The first, the second and the third group are now working in various Government Departments and private sectors as system programmers and system analysts. ITB is also conducting part-time computer courses and short courses mainly for officers and staffs in Government Departments.

ITB is well equipped with computing facilities for use by staff and students. The main computing resource, which is shared with Saiful Rijal Technical College, is a PRIME 'super mini' computer. This machine has 8 megabytes of main memory and over 600 megabytes of backing store. It can support up to 36 users at any one time. The Saiful Rijal Technical College will have the PRIME computer in few years time. In addition to PRIME, ITB has two PC networks, each with 12 stations, for its own use. The systems architecture laboratory which has more PC's is located in a separate Block.

Computer courses are going to be offered by University Brunei Darussalam (UBD) to students in the coming semester i.e. August 1990. Recently UBD has made an initiative to offer computer appreciation course to students and the general public.

5. Computers in School Administration

Various administrative duties have been performed upon a variety of different computers in different schools. Some use BBC B or BBC Master whilst others use IBM compatible computers. The earlier BBC computers are really computers designed for use in classroom and are not suited to administrative work due to their lack of memory and lack of access to standard business software developed especially for the IBM computer ranges. Nearly every school had a different approach to the use of the computer for administration. At present there is no standard computer in the administration system that can be described as being in operation in all schools in Brunei Darussalam.

The amount of school management and administrative work taking place is wholly dependent upon the expertise, initiative and co-operation of certain individual teachers who have very often written or adapted the software actually used in their schools. The administration software is not always reliable as it is written by amateur programmers (i.e. teachers).

The following illustrates the use of computers in administrative work currently taking place in different schools, although again it must be recorded that most schools do only one or two, if any, of the listed tasks.

* Examination Question Bank	* Staff Details
* Processing Examination Results	* Pupil Records
* Examination Statistics	* School Budgets
* Typing of Examination	* Typing of Certificates
* Standardisation of Marks	* Production of Worksheets

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Problems and Issues

- (1) Lack of trained qualified computer teachers.
- (2) Poorly written software which can only be used if the author is available. Administration software is not always reliable as it is written by amateur programmers (teachers).
- (3) Most computers are very old and subject to frequent breakdowns. The servicing and repair of computers is unsatisfactory.
- (4) Since there are only 4-6 computers in each school only limited numbers of students may use the computers in appreciation clubs.
- (5) Computers available in secondary school are mostly BBC computers and are not suited to administrative work due to insufficient memory.
- (6) Administrative staff have not been fully trained in the use of computers.

Conclusion

Since 1987, the provision of computers to secondary schools has suffered from serious neglect owing to the transfer of the officer from the post of Computers in Education Project leader. However, 1989 has been the start of a revival of interest in the computers in schools project.

It is proposed that Computer Literacy be taught as a subject in schools by trained and qualified teachers and that the promotion of the use of the computer in all areas of the curriculum be undertaken. The extra benefits both to teachers and their students will be considerable, as it will improve the quality of teaching in schools as well as add a new dimension to schools life. Brunei Darussalam will benefit greatly having school leavers already trained in the use of the technology that they will undoubtedly encounter as working adults.

Computer education in Brunei Darussalam needs more active participation from teachers who can play a vital role in encouraging the use of computers in society. Experienced teachers can also assist the project by conducting more school-based courses for other members of the staff.

China

1. INTRODUCTION

Basically, the function of computers in education comprises two aspects: the computer as a subject of study and as an educational resource.

Computers are permeating a variety of educational activities of various types and at different levels as science/technology progresses and the electronics develops in China.

2. COMPUTERS IN EDUCATIONAL INFORMATION SYSTEM

(1) National Educational Management Information System

In order to provide educational policy-making and management with advanced technical support and to extend the dissemination of educational information in society, the State Commission for Education decided to set up a computerized NEMIS in 1985 for collecting, processing, analyzing and distributing educational and relevant economic and social information.

In accordance with this resolution, necessary facilities and professional personnel have been deployed in educational departments of central, provincial, prefecture/city and county governments as well as universities. In addition applied packages, including databases, processing models and methods have been developed.

At present, the principal part of NEMIS has been constructed. Some data banks, which include information relating to teachers in institutions of higher learning, students studying abroad and foreign students studying in China, have been built and put into operation. In addition various data processing, such as annual statistics of education, statistics and calculation of professional personnel and the survey of Chinese students' physique, has been conducted.

(2) Educational Documentation and Information

According to the 'Seventh Five-Year Plan of Educational Research' and a cooperating with local educational research institutions and universities, the division for educational information of the Central Institute of Educational Research (CIER) is developing a national Network of Educational Documentation and Information, which is working in coordination with NEMIS.

With nearly 100 computers and terminals, NEDI is composed of the national centre, local and special sub-centres and retrieving service stations. The function of this system is to develop databases of educational sciences; publish an educational index, digest and bulletin; disseminate news of educational experiments and research activities; and provide various information services, such as retrieving and SDI.

(3) Library Automation

Computers have been introduced into many libraries of educational institutions for library management and retrieval with the result that the dis-

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tribution rate and accessing of information and knowledge have been improved.

According to incomplete statistics, there were 48 minicomputers and 457 microcomputers equipped, 77 databases developed and a few terminals for international retrieval installed in libraries of China's universities and colleges in 1986.

3. COMPUTERS AS AN OBJECT OF EDUCATION

With the rapid progress of information technology, especially the increasing availability and use of microcomputers, computers have infiltrated every segment of society. More and more human beings are required to have a good command of computers. Learning about computers is becoming popular and has become an important component of various educational activities, such as adult education, vocational and technical education, and social education.

The emphasis of this outline will be on the use of computers for instruction in the regular education system, especially in primary and secondary schools.

(1) In Higher Education

The objectives of teaching/learning about computers in universities and colleges is to cultivate specialists with professional skills in computer science and technology.

There are 2 special computer colleges and 119 universities and colleges offering the speciality of computer science and its application; 22 offering computing in mathematics and software development; 61 offering computer software development and more than 10 offering informatics and computer communication in China's 520 universities and colleges of science, engineering, agriculture/forestry and medicine.

The students studying on other specialities also study some courses concerning computers in order to master the application of computers to solving problems in their professional fields.

(2) In Basic Education

In 1978, computer education began to enter Chinese secondary and primary schools in the form of elective courses and/or scientific activities outside formal classes. According to the resolution issued by the former Ministry of Education in 1982 and 1984, regular experiments have been conducted at some schools. Also, Centers for research and instruction have been set up in Beijing, Shanghai and other cities. It is estimated that more than 60,000 microcomputers have been installed in more than 5,000 schools. Taking into account the computers provided by the institutions of society for educational use, there are more than 80,000 machines accessible to the students of primary and secondary schools in China. Up to 1989, there were nearly 8,000 teachers engaged in computer education and approximately 3,000,000 students were trained in various computer courses and activities.

Computer awareness and basic programming are the main substance of study. The objective of instruction is to enable students to understand the fundamentals, structure and function of computers; study basic language and programming; accelerate students' abilities in logical thinking and problem-solving; and develop intelligence and creativity.

The main way of implementing computer education is by offering computer courses and conducting various outside class activities. Schools with the necessary facilities are required to offer computer courses and include these in their teaching plans. The class usually consists of 40-60 hours and the proportion of practice to theoretical study is 1:1 to 2:1. Students also learn about computers in the children's palace; student's scientific groups; community education centres and Computer Olympic schools. In order to promote the implementation of computer education and to raise the standard of study, an annual competition of children's computer studies has been held since 1984.

4. COMPUTERS AS A KIND OF RESOURCE FOR EDUCATION

(1) Computers Used for Management

Computers have been introduced into educational departments of central and local government for dealing with routine duties, such as handling of official documents and archives; planning and financial management; construction and organization of materials; personnel matters and foreign affairs. For example, there were 18 bureaus and departments of the State Commission of Education using microcomputers in their management work in 1986.

In many educational settings including schools, computers are used for teacher/student administration, processing examination marks and compiling student's records, handling financial matters and constructing timetables, making evaluations, etc.

(2) Computer Aided Instruction

Computers have been used in more and more schools as powerful tools to facilitate teachers/students teaching/learning across a wide-range of subjects, such as mathematics, physics, chemistry, biology, foreign languages and geography.

An annual exhibition, examination and evaluation of educational software has been held in China since 1988. According to the standard of evaluation, which includes educational functions (50 points), convenience for use (10 points), reliability (10 points), level of commodity (10 points) and programming skills (10 points), more than 2,000 software packages have been evaluated and 53 software packages recommended.

5. COMPUTERS IN EDUCATIONAL RESEARCH

The application of computers in educational research not only contributes to the combination of qualitative research with quantitative re-

search, but sometimes represents new orientations. For example, the interdisciplinary study on cognition, which integrates the methods and achievements of computer science/technology, with experimental psychology, brain science and linguistics is providing new insights into improving instruction.

Computers are commonly used for data processing and analyzing in many educational research institutions. For example, CIER as China's centre of IEA has been involved in an international assessment of science courses of instruction. At the first stage, sampling of physics, chemistry, biology and geography instruction in the second year of junior high school was made in three provinces/cities; at the second stage, the sphere of sampling was extended to 700 schools in seven provinces/cities.

Many studies and records of experiences have been made by teachers and researchers on various issues relating to computer education. These include topics such as the trend monitoring and strategy study, and the study on the impact of computers on instructional materials and teaching methods. Cooperating with local research institutions, CIER joined the "computers in education study international project". Three tools have been designed, sampling of 550 schools in 8 provinces and 1 city has taken place and data has been collected for input into the computer.

6. COMMENTS AND PERSPECTIVES

(1) Funds and Management

Local government are responsible for developing basic education in China. Local education authorities are the main vehicle for developing computer education in primary and secondary schools. They are supported by business, industry, parents, universities and social organizations. Local authorities decide on their own priorities, methods and rate of development according to needs, technical and financial resources.

In order to promote the development of computer education in a planned and organized way, the National Research Centre has been set up under the direction of the Bureau for Basic Education of China State Commission of Education.

(2) Uneven Development

China is a big country. Regions differ greatly in their economic development and in the conditions of running ways in which they run schools. Computer education presents uneven development both in quantity and quality. For example, computer education has enjoyed great attention and an annual investment of 2-3 million yuan in recent years in Beijing, where it is planned to popularize computers in senior secondary education. But in some regions, implementing computer education suffers from a lack of resources, qualified teachers and a supporting environment, even if it could be placed on the agenda as an urgent issue. China is also a developing country with limited resources and funds for education. Introducing computers into basic education has to proceed from actual conditions, develop steadily and emphasize practical results.

(3) Hardware

At present, the models of computers installed in secondary and primary schools are mainly APPLE mixed with LASER, IBM-PC and Chinese-made computers.

As the computer industry has developed, Chinese-made models have occupied more than 50% of the domestic computer market. Some computers have been exported. Special computers have been developed for students as the result of a joint effort by departments and parties concerned, such as Zhonghua Computer for Study. There are several models of this computer, which is compatible with Apple. The output of the Zhonghua Study Machine amounted to 80,000 in 1989. With relative low-cost and suitable software, Chinese-made machines are expected to be the main computers used in schools and by students at home.

(4) Software

The production and circulation of educational software/courseware in China generally proceeds through analyzing and defining the instruction task; writing the script; programming; appraising through exhibition, discussion and tests; modifying; evaluating and then publishing. This procedure assures the quality of software but needs a long span of time.

For facilitating teachers, who are the mainstay in developing educational software/courseware, tool packages and authoring software have been developed by universities, computer manufacturers prefectures, software centres and teachers themselves.

(5) Teachers

Most of the teachers working on computer education in primary and secondary schools are mathematics or science teachers. As bi-course teachers, they may have the advantage of integrating the computer with other subjects of instruction, but they have to divide their energy in dual courses.

The educational colleges in various provinces are responsible for teacher training. To train enough qualified teachers for computer education needs a unified course outline, teaching materials and training manual, which are being prepared. It also needs encouragement and a supporting mechanism as well.

(6) Research

As the use of computers in schools is accelerating rapidly, educators are not well-prepared on a theoretical plane to answer basic questions, relating to the nature and status of computer education, and the organic integration and mutual advance of computer education and general education. It has been recognized that computers should be used in conjunction with other educational means and methods and should be integrated into the whole process of improving the efficiency and quality of education, but we still lack experience in this regard.

Education has a history which goes back thousands of years. Com-

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pared with this, computer-based education is a completely new undertaking. It is of great importance that internal and international exchanges of information and experiences should take place. Closer relationships should be built between educators, computer scientists, psychologists, administrators, policy-makers and teachers, who should all make a concerted effort to explore the functions and applications of computers in education.

India

A country-wide programme for Computer Literacy and Studies in Schools (CLASS) was first implemented in 1984-85 as a pilot project covering 248 schools. The project was started with the following objectives:

- To provide students with a broad understanding of computers and their use.
- To provide hands-on experience;
- To familiarise the students with the range of computer applications in all walks of human activities and the computers' potential as a controlling and information processing tool;
- To demystify computers and to develop a degree of ease and familiarity with computers which would be conducive to developing individual creativity in identifying applications relevant to the immediate environment.

The emphasis in the programme was to be on manipulative skills rather than teaching of computer science.

The project has been extended on a year-to-year basis and 2,598 schools have been covered up to 1989-90.

The management system devised for the programme consisted of a Steering Committee jointly headed by the Secretaries in the Department of Education and the Department of Electronics. Computer Maintenance Corporation (CMC) Limited, a Public Sector Undertaking, was assigned the task of procurement of hardware, its assembly, testing and installation in schools and also the maintenance of faulty sets on a continuing basis. The National Council of Educational Research and Training (NCERT) was assigned the task of academic planning, curriculum development and teacher training. In the first year, BBC ACORN microcomputers and software were received from the United Kingdom under a bilateral trade agreement. The configuration of hardware initially provided under the project was 2 microcomputers (BBC ACORN), 2 single floppy disk drives (5.25"), 2 colour monitors, 1 dot matrix printer and 1 data recorder. The number of microcomputers being provided to each school has been increased to 5 microcomputers since 1987-88. To extend support to the schools and to train school teachers, initially 42 Resource Centers were selected from among existing institutions in view of the availability of qualified and experienced faculty in these institutions. The number of Resource Centers was subsequently increased to 60 in view of the coverage of schools having increased over the years.

Because of the limited number of microcomputers supplied to each selected school, all the students and teachers could not be covered under the project. Three teachers were selected from each school for training. They were to be from different streams but in practice most of the teachers have been of science and mathematics. Also, in practice, on an average two teachers from each school have actually availed themselves of training. The selected teachers were given 3-weeks training. Training programmes were designed by the NCERT which also organised the training of trainers. Each school was expected to cover 60 students under the Computer Literacy Programme. It was designed as a one-year programme including 30 hours of lecture time and 60 hours of practical, hands-on experience. This was not a part of normal curriculum and it was expected that the time assigned for

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Socially Useful Productive Work (SUPW) would be made available by the school to the extent possible for this programme and for the rest, the students would pursue the project outside school hours and during holidays. Although no special pay for teachers was envisaged under the project, an out-of pocket allowance was envisaged so that they could work beyond school hours and during holidays. A one-time grant for procuring relevant books supply to the schools selected under the project is given to NCERT and a recurring nominal contingency grant is given to each selected school.

From the beginning, it was recognised that a large scale programme could not be based on the import of either microcomputers or software. A Committee was appointed 1984 to examine these aspects and it recommended that:

- a) microcomputers should be introduced in schools because through a well organised programme, it can be ensured that the benefit of such technology reaches the remote and disadvantaged areas also. Microcomputers are getting introduced in the well provided schools in any case and if the Government did not intervene, the educational advantage of this technology will remain confined to urban areas and prosperous schools only;
- b) for large scale coverage of schools, the software ultimately has to be in the medium of regional languages because these are the medium of instruction;
- c) generation of indigenous software may be pursued vigorously to avoid undesired values from getting into the system.

These recommendations have broadly guided the implementation of the programme.

Efforts were made to start generation of software through NCERT and CMC Ltd. Twenty five software packages have been developed indigenously and supplied to schools along with other packages.

An evaluation of the pilot project was entrusted to the Space Application Centre. The study had two major objectives:

- to determine the extent to which the goal of demystification is achieved; and
- to evaluate various aspects of the CLASS Project so as to provide guidelines for the proposed expansion of the programme.

The evaluation study brought out the following:

- There was considerable enthusiasm for the programme.
- The objectives of demystification have been partially achieved.
- While every school has used at least the "Welcome Package", all the given packages could not be used generally as scheduling of the classes was not possible in the time table.
- The English language has posed problems for the students and even for some teachers.

- The process beginning with selection of schools and leading to installation of systems in the schools, has taken a long time (about 5 months) every year.
- The training of teachers has not been adequate and many teachers did not acquire the required degree of skill and familiarity with the microcomputers during training.

Recognising the fact that computer literacy will be crucial in preparing the children to cope with the microcomputer explosion, which has great potential for social change, the National Policy on Education 1986 stated that:

"A minimal exposure to computers and training in their use form part of professional education. Programmes of computer literacy will be organised on a wide scale from the school stage".

The Programme of Action prepared for implementation of the National Policy on Education envisages coverage of 10,000 higher secondary schools under the computer awareness programme. It also made mention of integrating this programme with the school curriculum at the lower secondary level. To recommend the reorganisation of the programme in the light of the evaluation report as well as the provisions of the National Policy on Education, a Working Group was set up which gave the following recommendations:

- The objectives as originally specified should be retained.
- The programme for the present should be at the +2 stage and should cover all the higher secondary schools.
- The hardware choice should be re-assessed periodically to ensure supply of the most suitable systems to the schools.
- The number of microcomputers in a school should be enough to cover all the students at +2 stage which would mean supply of 5 to 8 microcomputers per school, depending on enrollment.
- Use of Indian languages, which are the medium of instruction in schools, must be maximised both in hardware operation and as the medium of software.
- A large programme of software development is essential for the success of CLASS Programme.
- Resource Center's support to schools be provided at the district level.
- NCERT should be the nodal agency for the academic programme.

On the basis of the recommendations of the Working Group an expanded programme on computer literacy/education is under consideration in the Ministry. This programme envisages setting up of 400 District Resource Centers, 50 Regional Resource Centers (to be located as far as possible, in existing institutions), coverage of all senior secondary schools in the country, more intensive training of teachers and a large effort towards software generation in English as well as regional languages. It is also proposed to introduce computer education into the school curriculum and make it an examinable subject in Class XII so as to ensure that the subject is given the importance it deserves. Since any such programme is necessarily hardware oriented, the cost outlay is very large. Due to paucity of funds the expanded programme has not yet been finalised. Efforts are being made to identify sources for funding.

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However, any expanded programme is likely to have certain inherent obstacles which only meticulous planning and careful implementation can help overcome. Even if all higher secondary schools are covered in a phased manner over a 3 to 5 year period, the number of schools remaining to be covered would still be extremely large. Procurement, supply and maintenance of hardware in such large numbers and in remote and rural areas is likely to lead to slow progress in implementation. The number of teachers to be trained would be very large. To identify existing institutions which could provide effective training to teachers in such large numbers would also, at least at the initial stages, be a difficult task. Another major problem likely to be faced is non-availability of software in regional languages. Given the inadequacy of facilities in Government schools specially in the rural and remote areas, it is possible that some of the senior secondary schools would not have the basic necessary infrastructure of space and electricity for the introduction of computer education. Administrative procedure would need to be streamlined and decentralised so that monitoring and evaluation can be effective. These are some of the areas which would need very special attention at the time of implementing any expanded programme in this specialised field of education.

Private high fee charging schools have introduced computer education with the help of private institutions involved in conducting courses in computers. In such cases the school enters into a contract with a private organisation and the organisation takes full responsibility for the following:

- Setting up a computer centre in the schools with a specified configuration of hardware;
- Familiarising all teachers with computers;
- Specialised training to 2-3 teachers to enable them to take over the centre at the end of the contract period;
- Important instruction to children;
- Provide all required software.

Thereafter, at the end of the contract period, the private organisation withdraws and the school is left with a fully functioning computer centre with adequately trained teachers. The centre is funded through charging fees ranging from Rs. 40-50 per child. To supplement the Government effort in expanding the base of computer education in State schools, the possibility of involving reputable voluntary agencies/private institutions is also being considered and a project report detailing the means of bringing this about is under preparation. It is felt that involvement of reputable private organisations would have a cyclic effect on production of hardware, generation of software, an increase in public awareness as well as increased demand for facilities for computer education. Since charging of fees from students in Government and Government aided schools may not be possible it would need to be decided to what extent the Government would subsidise such a programme. It is expected that the project report will take care of all these details and recommend the process by which the private organisations can be involved in the computer literacy programme.

In recent years there has been large scale mushrooming of private institutions offering courses in computer education, charging exorbitant fees. The quality of instruction imparted is not necessarily standardised. In the absence of any large scale Government effort towards computer education in

schools there is likely to be exploitation of interested students by these organisations. There already exists a vast gap in the availability of facilities and level of competence amongst students from private high fee charging schools and Government and Government aided schools. In order to reduce these disparities and to raise the level of competence, as well as to ensure that the students coming out of the large number of Government and Government aided schools are not only computer literate but have the option to go in for specialised computer education, it is felt that a large scale Government supported programme in the schools is essential.

Japan

Introduction

The extent of the use of computers in education in Japan, particularly in elementary and secondary schools, has been rather limited, although experimental projects on the use of computers for CAI/CAL in schools have been undertaken for more than 20 years mainly by researchers and professors at universities. The low use rate is partly due to the fact that up to now in the official school curriculum, i.e. the Courses of Study issued by the Ministry of Education, computers have not been treated as a part of the teaching content except for the curriculum of vocational upper secondary schools, so only a limited number of schools have been using and giving instruction about computers.

With the rapid development and extensive use of computers in society and in business in particular, a need has come to be felt to introduce computers into education and to give instruction about computers as well as to make use of them for other than administrative purposes. Currently, an increasing number of schools are being equipped with microcomputers and they are trying to make use of computers for the improvement of instruction and to teach children about computers. Various surveys including the one coordinated by the International Association for the Evaluation of Educational Achievement (IEA) have been conducted to find out the present situation and trends in terms of the use of computers in elementary, and lower and upper secondary schools, and some of the results will be discussed in the following sections. The data quoted below without named sources are from the results of the national surveys conducted by the Ministry of Education, Science and Culture.

1) Availability of Microcomputers in Schools

As shown in Table 1, according to the national surveys conducted in all public schools by the Ministry of Education, Science and Culture, 0.6% of elementary schools, 3.1% of lower secondary schools and 56.4% of upper secondary schools had more than one microcomputer in 1983. In 1989, these figures increased to 21.0%, 44.8% and 96.3% respectively. This increase was achieved partly because of the measures taken by the Ministry of Education to facilitate the introduction of computers in view of the emerging need to prepare children for the forthcoming information-oriented society. The Ministry started to subsidize the purchase of computers by public schools in 1985. Subsequently, in line with this, local governments have also been encouraging the introduction and use of computers in schools through their subsidy systems. But as shown in Table 2, the introduction of computers into schools has not progressed to the extent it deserves, especially in terms of the number of computers installed in each elementary and lower secondary school. As of March 1989, the average number of computers in those schools that have computers is 3.0 computers per school for elementary schools, and 4.3 and 25.5 for lower and upper secondary schools respectively.

Table 1: Diffusion Rate of Computers in Public Schools

	Elementary Schools	Lower Secondary Schools	Upper Secondary Schools
May 1, 1983	0.6%	3.1%	56.4%
Oct. 1, 1985	2.0	12.8	81.1
March 31, 1987	6.5	22.8	86.3
March 31, 1988	13.5 (3,337)	35.6 (3,748)	93.7 (3,925)
March 31, 1989	21.0 (5,172)	44.8 (4,740)	96.3 (4,035)

Note: The figures in parentheses are the number of schools with computers.

Table 2: Average Number of Microcomputers per School

	Elementary Schools	Lower Secondary Schools	Upper Secondary Schools
March 31 1988	2.9 (9,523)	3.5 (13,199)	19.7 (77,420)
March 31 1989	3.0 (15,505)	4.3 (20,519)	25.5 (103,014)

Note: The figures in parentheses are the number of computers installed in schools.

More than eighty percent of computers installed in schools have been purchased by schools with the help of subsidies from both national and local governments as shown in Table 3.

Table 3: Methods of Procurement of Microcomputers (Year: 1989 and 1988)

	Elementary Schools		Lower Secondary Schools		Upper Secondary Schools	
	1989	1988	1989	1988	1989	1988
Purchase	81.4%	81.0%	83.8%	80.0%	80.4%	82.6%
Rental/Lease	11.4	9.6	9.2	8.1	17.1	13.4
Others (1)	7.2	9.4	7.0	11.9	2.6	4.0
Total number of computers in schools	(15,505)	(9,523)	(20,519)	(13,199)	(103,014)	(77,420)

(1) Donations/gifts, etc.

As of 1989, about 40% of computers installed in elementary schools are 8-bit machines, and about 20% each of those in lower and upper secondary schools are also 8-bit machines. However, the majority of computers installed in schools are 16-bit machines and there is an increasing tendency to install more 16-bit or even 32-bit machines in schools.

Table 4: Type of Computers in Schools (Year : 1989 and 1988)

	Elementary Schools		Lower Secondary Schools		Upper Secondary Schools	
	1989	1988	1989	1988	1989	1988
8-bit machine	39.9%	45.8%	19.4%	26.0%	22.5%	29.1%
16-bit machine	58.3	53.0	79.2	73.0	75.5	68.9
32-bit machine	1.3	0.5	1.0	0.3	1.1	0.6
Others	0.5	0.7	0.5	0.7	0.9	1.4
Total number of computers in schools	(15,505)(9,523)		(20,519) (13,199)		(103,014) (77,420)	

Regarding the location of computers (see Table 5), the survey showed that many schools keep their computers in the faculty rooms or teachers' rooms. However, there is a growing tendency to keep computers in computer laboratories, in special rooms reserved for the teaching of certain subjects, or in multi-purpose or audio-visual rooms. One of the major reasons for keeping computers in teachers' rooms apart from the security factor is that many schools which introduce computers for the first time tend to use them for administrative or management purposes in the beginning due to the availability of the number of computers as well as the number of teachers who can operate computers in the schools.

Table 5: Location of Computers in Schools (Year: 1989 and 1988)

	Elementary Schools		Lower Secondary Schools		Upper Secondary Schools	
	1989	1988	1989	1988	1989	1988
Computer Laboratories	9.4%	10.3%	16.5%	14.2%	49.3%	43.4%
Special Rooms (1)	10.9	10.2	12.2	12.3	48.2	42.1
Classrooms	5.9	6.1	1.6	2.3	2.3	1.6
Libraries	3.6	3.5	2.6	2.1	6.9	3.5
Teachers' Rooms	66.4	74.3	63.0	71.2	55.1	56.7
Others (2)	19.5	16.0	29.9	21.4	41.4	29.8

Note: Computers are kept in more than one place, so the total percentage exceeds 100%.

(1) Such as special rooms for the teaching of science, industrial arts and home making, and audio-visual rooms.

(2) Such as multi-purpose rooms and in-school broadcasting studios.

2) Software Development and Use

The average number of software items possessed by public elementary schools in 1989 was 19.6, and 27.5 and 78.5 for public lower and upper secondary schools respectively. The number of software possessed by

schools has greatly increased from the previous year as shown in Table 6. However, many schools have multiple copies of the same software item, and the number of different kinds of software, excluding multiple copies of the same kind of software, possessed by schools is 6.2, 7.1 and 14.4 per school for elementary, lower secondary and upper secondary schools respectively.

Table 6: Number of Software Items Possessed by Schools (Year: 1989 and 1988)

	Elementary Schools		Lower Secondary Schools		Upper Secondary Schools	
	1989	1988	1989	1988	1989	1988
Average number of software items per school	19.6	9.5	27.5	8.5	78.5	18.3
No. of schools with computers	5,172	3,337	4,740	3,748	4,035	3,925
No. of software items possessed	101,623	31,808	130,306	31,991	316,768	71,738

Of the software items possessed by schools in 1989, 73.9%, 59.7% and 68.9% of software were commercial software items purchased by elementary, lower secondary and upper secondary schools respectively. The remaining software was either developed by schoolteachers or jointly developed by teachers and local education centers.

Table 7: Sources/Development of Software used in Schools (Year: 1989 and 1988)

	Elementary Schools		Lower Secondary Schools		Upper Secondary Schools	
	1989	1988	1989	1988	1989	1988
Teacher made	15.0%	14.6%	23.1%	18.6%	21.4%	34.0%
Joint development (1)	6.4	6.0	14.6	5.1	2.5	4.3
Commercial	73.9	72.6	59.7	69.7	68.9	56.9
Others(2)	4.8	6.8	2.5	6.6	7.2	1.8
No. of software items possessed	101,623	31,808	130,306	31,991	316,768	71,738

(1) Developed jointly by teachers and staff of local education centers, and by groups of teachers.

(2) Exchange with other schools, gifts, etc.

About 70% of the software possessed by elementary schools and lower secondary schools is for use in connection with subject teaching, whereas about 54% of the software in upper secondary schools is for this purpose.

Besides the software for use across subjects, software for Arithmetic,

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Science and Japanese Language is popular in elementary schools, software for Mathematics, Foreign Languages and Science in lower secondary schools, and software for vocational subjects, mathematics and science in upper secondary schools.

One of the interesting features of Japanese education is the development and the existence of an education industry. Textbooks are developed by private publishers, although they have to be approved by the Ministry of Education. Apart from textbooks, drills, worksheets, tests and supplementary instructional materials are also developed by private publishers and used in schools, and are also available in the market for home use. A number of educational magazines and periodicals for teachers, students and also for parents are published by private publishers and available in the market. The computer industry has also been growing and many private companies are paying attention to the field of education. Apart from manufacturers of computers, many companies are now developing and producing software for educational purposes and they are available in the market for schools as well as for home use.

An increasing quantity of commercial software is now available in the market, but evaluation of this is not yet systematically carried out. Although general guidelines for the development of software have been issued by the Ministry of Education in order to ensure the high quality of software, but the selection of, or the method adopted for the evaluation of, software is up to the user.

Some information on the content and evaluation results of new software is disseminated through monthly magazines and journals published by private publishers. A semi-governmental organization established in 1986 is engaged in collecting and evaluating software developed by teachers and schools as well as that used in pilot/experimental projects, and in making the results of the analysis available to users.

3) Curriculum

The Courses of Study for elementary, lower secondary and upper secondary schools have been revised almost every 10 years, and the most recent revision has just taken place. New Courses of Study will be put into practice from 1992 for elementary schools, from 1993 for lower secondary schools and from 1994 for upper secondary schools. In the new Courses of Study, computers are expected to be more positively used than now in the teaching of various subjects, and computer education will be covered by such subjects as industrial arts and homemaking in lower secondary schools, as well as such subjects as mathematics and science in both lower and upper secondary schools, as well as vocational subjects in vocational and technical upper secondary schools.

According to the new Course of Study for elementary schools, it is expected that use will be made of computers for the improvement of teaching and learning, and that through the use of computers as an aid children will make themselves familiar with computers. But it is not expected that the functions and operation of computers will be taught at this level. In the Course of Study for lower secondary schools, it is expected that use will be made of particular characteristics and functions of computers such as

simulation and information retrieval for instruction and that through such use of computers children's understanding of computers will be deepened and necessary skills will be developed. In the subject "Industrial Arts and Homemaking", there will be a requirement to teach the content of the foundation of information, especially computers, to both boys and girls. In upper secondary schools, in the teaching of each subject, proper attention has to be given to the emergence and development of an information-oriented society and the impact of computers on individuals and society. A new subject area called "Mathematics C" will be introduced to teach children about computers focusing on computer use.

4) Teachers

A suggested training program has been developed by the Media Committee of the Social Education Council, and the Ministry of Education as well as local (prefectural) governments have been providing interested teachers with opportunities for in-service education in the use of computers. In particular, prefectural boards of education make use of their education centers or establish information processing education centers to provide training opportunities for teachers. However, in-service teacher education provision varies from prefecture to prefecture. Teachers who wish to undergo training are provided with an opportunity for training on the basis of the availability of courses. Teachers interested in the use of computers may also find their own ways of getting trained at their own expense, as private companies provide teachers with opportunities for training on computers. Topics covered by training courses vary from course to course depending on the specific objectives/purposes and levels (beginner, intermediate, advanced, etc.) of courses, and the levels or backgrounds of participants. A training course normally covers general theory, and the operation, programming and application of computers. Pre-service teacher education programs with respect to computers also vary from institution to institution.

According to the survey conducted by the Ministry of Education last year, 7.6%, 14.5% and 30.2% of public elementary, lower secondary and upper secondary school teachers respectively responded that they can operate computers, and only 19.9%, 25.8% and 44.3% of these elementary, lower secondary and upper secondary school teachers respectively responded that they can teach about computers. So far, about 95,700 teachers have undergone some form of training in the use of computers, and a little over half of them (54%) received training organized by national and local government/prefectural education centers. Those teachers who are able to operate computers are teachers of mathematics and science in the case of lower secondary schools, and those of vocational subjects, mathematics, science in upper secondary schools.

As for the opinions and attitudes of teachers toward computers, it was found from the data of the IEA Computers in Education study made in early 1989 that teachers are generally in favor of computers and have positive attitudes and opinions about the role of computers in society as well as in education. They tend to consider computers as a valuable tool to improve students' learning and enhance teaching effectiveness, and they are eager to learn more about computers as a teaching aid. However, due to the lack of systematic in-service teacher education programs on computers in the

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past, most teachers, especially those who are not using computers, consider that they do not know much about computers or their operation.

5) Problems

Since the introduction of computers into schools has only just started, there are a number of problems yet to be solved before full and effective making use of computers in education as well as providing education about computers. Some of the pertinent problems observed by teachers in the school are centered around problems of software, the training of teachers and financial provisions. According to the data collected for the IEA Computers in Education study, several problems are commonly rated by many computer coordinators in elementary, lower secondary and upper secondary schools as those which are seriously affecting their school's ability to use computers effectively

Table 8: Serious Problems Affecting the Use of Computers in Schools

Problem	Elementary	Lower Secondary	Upper Secondary	
			General	Voc/Tech.
not enough software for instructional purposes available	93.0%	95.2%	88.4%	87.5%
lack of information about software or its quality	73.2	76.7	72.3	74.5
teachers lack knowledge/skills about using computers for instructional purposes	85.5	81.9	77.1	69.8
insufficient training opportunities for teachers	87.3	85.6	83.5	76.6
inadequate financial support	72.8	75.6	81.9	78.5
not enough time to develop lessons in which computers are used	83.8	85.3	88.7	85.7
N: (228) (270) (310) (321)				

Source: International Computers in Education study, sponsored by the International Association for the Evaluation of Educational Achievement (IEA). National Institute for Educational Research (NIER), Tokyo, unpublished data.

6) Policy Directions and Measures taken by the Government

A large number of experimental or pilot projects on computer education have been or are being undertaken by various groups. Such projects are undertaken by schools themselves, by or on the initiative of education centers or educational research institutes, and by universities. However, the overall responsibility for the implementation of the use of computers in education rests with the Ministry of Education and local (prefectural, municipal) boards of education, especially in the case of public schools.

It was pointed out in the recommendations and proposals made by various councils and committees of the Ministry of Education in the early 1980s that there was a need for school education to properly respond to the rapid transition of society as it moves toward a highly information-oriented/-based society. Some of the important policy directions incorporated in these recommendations are:

- development of the ability to utilize and handle information through school education and life long education;
- application of new information technology and media to education;
- development of human resources which will be able to lead in the information-oriented society;
- promotion of the use of information technology in educational policy administration and the development of various databases.

In particular, it was emphasized the development of an ability to utilize information or so-called information literacy and it was defined as the basic capability of each individual to actively make use of information and information media. It was also conceived that such ability or information literacy is composed of or fostered by the following:

- Development of the ability to judge, select, reorganize and process information as well as to create new information, and the development of communication skills;
- Appreciation of the characteristics of information and an information-oriented society and the impact of information on such society and human beings;
- Recognition of the significance of information and the development of a sense of responsibility for information; and
- Understanding of the foundation of information science and the characteristics of information media, especially computers, and the acquisition of their manipulative skills.

As already referred to under the section on the curriculum, in the report of the expert meeting organized by the Ministry of Education to discuss the basic principles for introducing computers into schools, the following was proposed: "In elementary schools, the use of computers should aim at the improvement of learning and teaching methods, and in principle, children should be brought in contact with computers, get accustomed to and become familiar with them through the use of computers as a teaching aid, but instruction only for the purpose of understanding of the functions and operation of computers should not be provided at this level". The new Courses of Study are also expected to facilitate the use of computers and the teaching about computers in secondary schools.

A special subsidy system for the procurement of computers by public schools was launched in 1985 by the Ministry of Education, and the introduction of computers has been promoted under this system since then. In line with the enforcement of new Courses of Study, it is planned to install computers in all public schools by 1994.

In 1986, eight schools were designated by the Ministry of Education to undertake experiments on computer education, and since then two dozen schools have been designated to carry out experimental studies every year. Also, the Center for Educational Computing (CEC) was established in 1986

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jointly by the Ministry of International Trade and Industry and the Ministry of Education to undertake research studies concerning computers in education and to design computer hardware suitable exclusively for educational purposes in order to promote computer education and the use of computers in education.

Malaysia

On January 9, 1989 the Minister of Education agreed that the Ministry of Education should implement Computers in education (C.I.E.) as a national program. Following that decision, the C.I.E Unit was established under the Schools Division to plan, implement and promote all activities regarding C.I.E and coordinate all C.I.E programs which are conducted by all other Divisions.

The innovative project, as a result of one and half years of planning by the Ministry of Education - Malaysian Institute of Microelectronic System Joint Committee is expected to commence at the start of the second semester in October 1990.

The Ministry of Education is preparing to launch a project exploring the viability of using personal computers (PCs) in secondary school around the country.

SETTING THE GOALS

There is no doubt that computers have become a way of life. In Malaysian society, computers are used in almost every aspect of our lives. The schools, being the centre of knowledge acquisition and the agent of change, are therefore the first places in which a computer literacy program will be initiated. It is in schools that our future generations will acquire the important skill of using computers to bring development and the latest technology to our nation.

The goals of the C.I.E project are firstly to educate our young to use the computer as a functional tool. The literacy program should aim at producing a generation of computer users. To be computer literate is to be able to use computers to perform specific tasks in our everyday lives.

The second goal is to use the computer as a teaching/learning tool. PCs will be used as teaching aids, just like overhead projectors. Therefore teachers in secondary schools will use PCs equipped with special educational software called courseware to assist in the teaching of such subjects as Bahasa Malaysia, English and Mathematics.

THE PLAN

With the establishment of the C.I.E Unit, it was decided that the implementation of C.I.E program should be through 3 phases:

The Preparatory Phase (1989 to 1990)

During this phase of implementation the Unit will;

- 1) evaluate existing software and available applications;
- 2) develop software and additional applications;
- 3) provide training for future software developers and users and;
- 4) carry out a research and development program.

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The Experimentation Phase (1990 to 1992)

During this phase, ample numbers of schools will be chosen as pioneer schools to experiment with the C.I.E. program. These schools are regarded as field laboratories to determine the direction of C.I.E in Malaysia.

The Implementation phase (1992 onwards)

During these phases full implementation will be carried out in 1,300 secondary schools throughout the country in 5 stages. Meanwhile R & d will continue.

Important Variables to Consider in Making Computer Placement Decisions

Having identified the goals of applications and curriculum integration, it is important to examine the requirements for the implementation of the project. There are many variables to consider when deciding on how and where computers will be placed in a school, some of the factors that require careful consideration include: 1) Hardware; 2) software; and 3) teacher training.

1) Hardware

Malaysian schools vary in size from a few hundred students in some smaller schools to those with more than a thousand students. Except for some residential and elite schools, the average class size is generally big; sometimes to the extent of 50 students in a class. In terms of facilities, academic standards and computer awareness, there are also large variations. The rural schools are generally not as well equipped as the urban schools. In terms of exposure to computer facilities, rural students are also in lesser contact when compared to urban students. About 90% of the schools in urban centres have computer clubs compared to less than 30% in rural school. Socio-economical factors also play an important part. The urban parents, especially those in the higher income brackets, are even able to provide their children with home computers. All these factors serve to make the computer literacy project a very difficult one.

In terms of hardware requirement, it is therefore very difficult to determine the actual amount of hardware needed.

Hardware standardization is an important factor to consider for the proper implementation of the project. Then there is a question of system. How are the PCs going to be used? Are they to be used as a stand alone? Or should there be some sort of networking? Are they directly used as instructional tools? Or are they to be used as educational aid to handle tutorials, tests, keep records or disseminate data? These are some of the questions we have to answer in order to arrive at a proper assessment of hardware needs.

2) Software

Software requirement for learning with computers are tremendous. Each subject in the secondary school curriculum has to have access to relevant software. This software has to be developed locally. This will require a concerted effort from all educators and teachers alike.

In the context of software, we can divide schools into "haves" and "have-not". What is urgently needed is to bring the two groups together so as to pool resources and encourage cooperation. Time and effort as well as money may be saved, if schools can gain access to software without actually developing it. By bridging this gap, Malaysia may one day be able to start a SHAREWARE concept for schools. The advantage of such a scheme will include:

- 1) software development suited, tested and appropriate to Malaysian requirements.
- 2) developing honest values in the end-user because the SHAREWARE concept encourages a satisfied user to pay the developer of the software a token sum. This will encourage the developer to improve the software based on feed-back.
- 3) satisfied users who pay the token sum will be supplied with manuals, documentation, etc.

3) Training

Teachers form an integral part of the learning with computers program. Unless our teachers themselves are computer literate, they will not be able to handle the program efficiently and effectively. Many teachers are very much entrenched in the current methods of instruction such as using the blackboard and chalk, or transparencies with an overhead projector. Learning a new skill becomes somewhat troublesome for many. There is also a fear of new technology. It is therefore important that some sort of re-orientation should take place where by present teachers would be encouraged or coaxed into using computers as an instructional tool. May be these teachers should undergo some training programs with the aim of making them computer users. Those who are very keen can even be taught to become programmers or software authors.

Last May 1990, the C.I.E Unit conducted a training session for 30 secondary school teachers for a period of two weeks. During this session, the C.I.E Unit exposed these teachers to the computer literacy program as well as the Linkway authoring tool. In fact by the end of September 1990, i.e before supplying computers to schools, there will be about 180 trained teachers.

PRESENT ACTIVITIES

Various projects have been carried out by the C.I.E unit as well as other interested parties in C.I.E such as:

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1) School Computer Club

A computer literacy program has been included as an extra curricula activity (ECA) in the schools since 1981. Schools are encouraged to establish computer clubs on a voluntary basis. These schools are expected to find their own financial support for their activities. At present, the numbers are more than 60% of the 1,250 secondary schools.

Each computer club is equipped with one to twenty set of mainly IBM compatible PCs. By October 1990, computer literacy will be implemented to Form One students as part of the manipulative skills program.

2) Institute Aminuddin Baki

Since 1987, the Institute Aminuddin Baki (IAB) has conducted short courses of computer exposure for educational staff. Beside that, IAB conducted a 3-month course in educational computing.

3) Manjong District Primary School Project

The Manjong Project was initiated in 1988 by the State Education Office in Perak. More than 78 primary schools were supplied with computers at the ratio of one computer to fifty students. This project was organized by a private company. This project include computer literacy as well as teaching/learning with computers in Arithmetics, Malay and English Language. All the software and courseware was written by personal at the company's resource centre.

4) Teacher Training Colleges

The training of new teachers would also have to take into consideration the use of computers as an instructional tool. All future teacher trainees have to be able to handle computers as an application tool. Basic programming should also form an important part of the training program. This is to ensure that our future teachers are able to write software for the curriculum. Therefore the lecturers in the teacher training colleges and universities have also to be re-oriented to handle the new technology.

There are 28 colleges around the country. Some of the colleges likes Institute Sultan Idris Tanjung Malim, Temenggong Ibrahim College Johor Bahru and Sultan Abdul Halim College Sungai Patani manage to incorporate computer literacy as part of their curriculum. These colleges have given the basic student 2-hour exposure a week, while in other colleges, computer literacy was treated as co-curriculum with an exposure of one hour a week through computer club.

At the Technical Teachers Training College, computers are widely used especially by the commerce students. About 20% of their curriculum is based on computers. The technical drawing students use AUTOCAD programs. There are about 35 computers in this college.

Another college, the Specialist Teachers Training College, is offering a course in Educational Technology in which computers are an integral part of the curriculum.

5) Vocational School

At present there are 56 vocational school in the country offering courses in Engineering Trades, Commerce, Home Science and Agricultural Science. Out of these 48 schools are offering Commerce courses.

The Commerce curriculum is comprehensive and flexible to suit the changing needs of technology. Basic computer application knowledge is also included in the Commerce curriculum in order to allow students to adapt themselves progressively to new methods of work and to acquire greater proficiency.

6) Polytechnic

Six polytechnics have been established since 1969 as institutions for technical business training. Their main objectives are to train school leavers from secondary schools as qualified engineering technicians and as middle-level executives.

In view of the national push towards industrialization and economic expansion, most of the students are being exposed to computer applications. The Computer Application paper is, therefore, a core paper.

7) Tertiary Education

In December 1987, the "Computer-Assisted Language Teaching" course at Universiti Pertanian Malaysia was introduced to cover the following aspects:

- 1) A basic introduction to the parts of a computer, and elementary safety precautions, through the use of demonstration and a video.
- 2) Using simple graphics packages, such as Print Shop, Print Master, Newsroom and Fontasy, to produce imaginative and high quality teaching aids.
- 3) Use of a word-processing package.
- 4) Familiarization with a wide range of educational computer programs, such as Word Attack, Speed Reader, Eliza, many with authoring facilities, which could be used in the teaching of English.
- 5) The use of an authoring tool to write programs suitable for teaching English.
- 6) Programming in BASIC to write simple program suitable for teaching English.

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A multi-dimensional approach was used such as:

- 1) Students were introduced to increasingly complex packages and programs, to develop their computer literacy, using a ready-made educational software.
- 2) At the same time, the course focused on how the software could be used to teach English. Hence there was a progression from the teaching of writing to the teaching of reading, grammar, vocabulary, and oral communication skills.

While Universiti Sains Malaysia conducts courses in Educational Technology at Certificate level, computer literacy is also included in the curriculum for those who are taking a Diploma in Education.

As a result of this wide range of programs being implemented by all the universities, all newly graduated teachers are all computer literate.

8) Private Sector

A multi-million ringgit C.I.E project which involves the use of PCs hardwares has attracted the attention of every local vendor, while local software houses are also hopeful that the project will spark off a big demand for locally developed educational software. A few companies such as Uniphone (Apple Division) and Mesiniaga (IBM) are already forcefully marketing their HyperCard and LINKWAY authoring tools.

Recently Uniphone (Apple Division) announced an Apple Education Exchange Programme to trade-in any compatible machine with Mac SEs with 20MB hard disks and other peripherals for about 50% of the discount price, with the condition that the buyer must be an educationist and produce 3 software packages using HyperCard. Beside selling their hardware, Uniphone (Apple Division) conducted courses and training for software development.

Mesiniaga, to ensure their share of cake, offered a special price with their product and also conducted courses and training in software development using LINKWAY.

To make this project a success, computer vendors need to come forward and offer their support, not only in term of equipment, but also to provide their expertise.

ISSUES AND PROBLEMS

Educators and administrators are bewildered by technology and its capabilities, by the large number of companies marketing PCs, by the rapid rate of new developments in microcomputer technology, and by the wide range of models and peripherals available.

Computer companies perceive the education market as lucrative. As result, they direct slick advertisement and very persuasive salespeople at educators. Salespeople usually are more interested in making a sale than

they are in meeting the needs of their customers. Because many educators have no competent, objective person to give them the help they need, they turn to the salespeople for advice and sometimes buy computers that do not meet their needs. The result is frustration, disappointment, and frequently, disenchantment with the entire concept of C.I.E.

Purchasing computer hardware and software may be compared to purchasing automobiles. On our and we see a wide range of automobile models with different size and interiors, different engine power, two or four doors, and so on. Some people buy Sagas, some Toyotas, and some Hondas. The automobile owner uses a variety of criteria - some objective and some subjective to make a decision. The diversity of cars on the road indicates that is no single automobile that is the best - just as there is no single microcomputer that is the best in every educational situation.

Therefore guidance is needed in the shape of specific criteria can be applied to help users make rational decision about the best type of computers to meet their needs.

Certain standardization is required for the hardware and software so that all the people involved will be familiar with a similar computing environment. This will improve job efficiency and productivity as more time can spent on the creative aspects of using the computer as a tool. The teachers can also be moved freely without much re-training and can interact with each other easily as they would have a similar background. The standardization of the following aspect should be considered:

Processor - The type of CPU "chip" determines processor flexibility. Chips on which standard operating systems such as CP/M (Control Program for Microcomputers) can run provide more flexibility and future compatibility. Popular CPU's include the INTEL chips 8086 series, Z-80, 8080. Another popular chip is the Motorola 6502, which is used in several computer systems.

Operating System - The primary function of an operating system is to provide an interface between users, application software and computer hardware. The OS plays a major role in creating upward compatibility for the users to move to a larger or new system. At present there are various OS on the market such as CP/M which is one of the most used for 8-bit PCs, MS DOS the most widely used for 16-bit PCs, UNIX and many others.

Although the costs of more powerful computer hardware are coming down, this is not enough to convince the top level management the benefit from introducing computers to schools. In developed country, the cost of hardware only accounts for a minor proportion of the total cost be of a C.I.E program about 10%. A great deal more will have to be spent on software (20%) and on teacher training (70%).

CONCLUSION

The full implementation of the C.I.E Policy will lead to the creation of a society that is not only computer literate but one which is well prepared

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for the 21st century.

With proper exposure to IT, Malaysians will be well prepared to usher in the information age, a challenging period that will be characterized by the mushrooming of economic activities that centre around the production and exploitation of information and knowledge.

New Zealand

Background to the use of computers in schools

The formal use of computers in New Zealand schools had its beginning in the early 1970s when a new Year 12 (Seventh Form) Applied Mathematics course was introduced which required the use of computers. The emphasis in this section of the course was on programming, achieved through a postal batch-processing system organised through the commercial banking network.

The use of computers is characterised by rapidity of change. Thus, with the availability of microcomputers in the late 1970s and early 1980s, the potential for wider uses for computers in education was soon recognised, together with a need for a more general computer education for all students to prepare them for life and work in a new technological environment.

The Department of Education set up a Consultative Committee on Computers in Schools to provide a direction and coherence for developments. The report of this committee which was published in February 1982 recommended that the priorities for future developments should be in the following three aspects:

- 1) computer awareness for all secondary students;
- 2) computer studies for secondary students close to school leaving age;
- 3) the use of computers as a teaching tool or aid, in all subjects of the curriculum, and for remedial purposes.

Computing in primary schools was considered at that time to be outside the brief of the committee.

The Department produced a computer awareness resource comprising student material and a teacher's guide to support a 12 hour course pitched approximately at Year 9. The course aimed, in simple terms, to teach what a computer is, what it can do, and its effect on people.

A 120 hour computer studies course outline was prepared for Year 11 students, to be taken as an elective. Programming accounted for about half of this course, with computer structure, applications, history, and social implications completing the course.

While many of the recommendations of the Consultative Committee have stood the test of time - 1982 to 1990 is a long period in computing terms - some priorities have now changed.

Computer awareness is now considered unnecessary, as most students are entering secondary schools with a working knowledge of classroom computer applications. This has changed the emphasis to the use of the computer as an aid or tool. Computers are seldom studied but are integrated more into the students' learning.

The emphasis in the year 11 computer studies course has also changed, with less attention being paid to programming. A year 12 computer

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studies course was introduced in 1989.

Following the report of the Consultative Committee, the Computer Courseware Development Unit was established within the Curriculum Development Division of the Department of Education. As its title suggests, there was an expectation that this unit would develop educational software, but its main function was to provide advice and support to schools on the selection and use of educational software and hardware. Initially, the Unit had a staff of two.

The rapid growth in the use of computers in primary schools forced the recognition that the original purpose for which the unit had been created was neither appropriate nor achievable. The staffing of the unit was expanded to four professional officers, the name was changed to the Computers in Education Development Unit, and the work of the unit was changed to one of providing advice, training teachers and supervising research in schools.

While at the time it was clear that the government had a general policy of support for educational computing, there were for educational computing, there were considerable constraints imposed by the availability of resources. There has never been an allocation of government funding for the provision of hardware or software in either primary or secondary schools. Almost all the large number of computers currently in schools have been provided by locally raised funds. A recent survey indicates that this represents an expenditure of more than \$NZ49 million.

The current position

The restructuring of educational administration in New Zealand under the policy of *Tomorrow's Schools* required the dismantling of the Department of Education. In its place a Ministry of Education was created. The Curriculum Development Division was disbanded and so too was the Computers in Education Development Unit. This ended the provision of any central coordinating agency for educational computing in New Zealand.

Recognising that there was a continuing need for advice to schools on educational computing, the planners created six advisory positions. These were entitled District Adviser in Educational Computing and one was allocated to each of the six Colleges of Education. These six advisers have a contractual arrangement with the Ministry of Education to undertake action research which they combine with their advisory role.

Consultative committee on information technology

The Minister of Education recently announced that a consultative committee on the use of information technology in education was to be formed. This committee is currently meeting in Wellington.

The terms of reference of this committee are that it will formulate a policy on the educational uses of information technology for implementation by the Ministry of Education. It must also devise a strategy and costing for

the implementation of such a policy.

The report of this consultative committee, due out at the end of June 1990, may have considerable impact on the future directions of educational computing in New Zealand.

The use of computers in schools

Microcomputers are commonly used in approximately 80% of New Zealand primary schools. The machines are almost universally deployed in classrooms with one or two per room with an attached printer. Schools now have more machines and these are of a greater capability than those of as little as two years ago.

Computers in the primary school are often used in the written language programmes. Word-processing as an integral part of the writing process is very common. Publication and illustration programs are also used in this context. Typically, where schools have chosen to use computers in this way, it has become the dominant or sole use of the hardware, and often accounts of the entire school day.

Many schools make use of interactive fiction software which acts as a context in which the curriculum needs in reading, oral language development, problem solving, decision making and group cooperative exercises can be met.

A number of schools also employ the Logo programming language both within mathematics and also in the more general context of problem solving.

In many classrooms simple database programs are used to support the collection and organisation of data in science and social studies. Statistical and graphing packages are also used in these subjects.

Drill and practice software in some curriculum areas, particularly arithmetic and spelling, though still used in some schools, is generally on the wane, as teachers discover more appropriate uses for the technology.

New Zealand secondary schools all have computer facilities. Recent figures which are not yet complete indicate that the average number of students per computer may be approximately 30. Secondary schools almost always have a *computer laboratory* but it is now very common to find an additional number of computers deployed in classrooms throughout the school. This has increased the use of computers across the curriculum.

Specialist subject areas of the school such as art, music, technical drawing and engineering workshop are using computers. The type of computer chosen is usually one that has proved to be particularly suitable for the demands of that subject.

Computer Studies Courses are offered at senior levels in nearly all secondary schools, either formally as part of a national qualification, or informally in connection with a student's broad, general education. During 1989 a syllabus for a Year 12 course was written and approved.

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Although the need for computer awareness, as initially envisaged, has decreased with the greater availability of computer hardware, many schools still include a study of the applications and social implications, often within a social studies course.

There is now considerably more emphasis on the use of computers, word processing and desk top publishing software in the written language programmes of schools. Many schools now have editorial teams with responsibility for the compilation and production of school newspapers and magazines. Recent indications are that this will be a growing trend.

Many teachers report the use of simulations in subjects such as economics, accounting, geography, the sciences and mathematics.

The change in the educational administration of schools in New Zealand now means that schools get all their funding in a bulk grant. The Board of Trustees of the school has the responsibility to spend this money in the best interests of the school. Previously the government funding did not contain an amount for computer hardware or software and so it is reasonable to assume that the cost of hardware is usually met from money raised locally but the school.

It has not been policy in New Zealand to specify or promote particular brands of microcomputer for use in schools. In spite of the apparent freedom of schools to choose from an almost unlimited range of hardware, the spread of brands currently in schools is not as great as might be expected, and is in fact smaller than in some states of Australia, for example, where state equipment recommendation schemes are employed. In both primary and secondary schools over 80% of the computers fall into three well-known makes. Over the last two years the MS-Dos computers have begun to make inroads. This is particularly so in the use of computer in the administration of schools. Many companies now produce software specifically designed for use in school administration.

The District Advisers in Educational Computing support the makes most commonly found in schools, and attempt to keep abreast of emerging technology. They give advice and guidance on both the educational and administrative uses of computers.

Teacher training

All six teachers' colleges have specialist staff to coordinate educational computing courses for pre-service teacher training. The colleges are equipped with substantial numbers of computers, held both in central "computer rooms" and distributed throughout the campuses. Courses in computing vary from college to college. It has become increasingly common for colleges to incorporate the use of computers in traditional subject courses such as reading, English, science and so on. Educational computing as a separate curriculum study is considered less important now than it was a few years ago, although such courses are still to be found in some colleges.

The change in educational administration has meant that there is no longer a central organisation which has responsibility for the organisation of

in-service training. This responsibility has passed to the teachers colleges who are ill-equipped for the task.

The money for in-service training has been given to the schools and they are then considered to be in a position to purchase the training and professional development they they consider they require.

Exploratory studies in educational computing

A major project involving the evaluation of educational computing in New Zealand schools was commenced in February 1986 and concluded in August 1987. This project was known as the Exploratory Studies in Educational Computing.

The purpose of these exploratory studies was threefold:

- to explore the most effective uses of microcomputers in New Zealand schools
- to gain experience of computer applications to the New Zealand school curriculum and methods of teaching
- to provide data to enable advice to be given to assist with the development of new policy with respect to computer education.

Schools were invited to submit proposals for studies involving particular uses of computers which interested them, and which they wished to explore further. Schools were also asked to suggest ways in which their proposal study might be evaluated.

In response to this invitation, just over one hundred separate submissions were received, embodying more than two hundred distinct proposals.

Fifteen studies, involving a total of 56 kindergartens, primary schools, intermediate schools and secondary schools were selected. These studies were to be well funded and fully and formally evaluated.

The schools involved in the major studies were loaned hardware, selected on the basis of the study proposal. In some instances, this hardware supplemented that already present in the school. The schools were also given grants sufficient to cover the purchase of the software which had been identified as appropriate to the study and the cost of consumable items. Teacher release time was also made available to facilitate some of the administrative tasks associated with the studies and their evaluation.

The New Zealand Council for Educational Research was contracted to monitor the research aspect of the studies, and two staff were employed full time to undertake this work. The evaluation instruments differed from study to study. In the studies of writing using word-processors, detailed analysis of writing samples, both computer produced and handwritten, collected from sample groups of children was undertaken. Samples were being monitored for frequency and type of editing, writing quality and comparative quantity. In almost all studies, extensive teacher and student interviews were carried out. NZCER designed and administered questionnaires for both children and teachers to determine attitudes to computing and computer knowledge both

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prior to the commencement and at the conclusion of the study.

Each study was managed by a committee which included the teachers involved, a member of the New Zealand Council for Educational Research staff, and a member of the Computers in Education Development Unit who regularly visited each study. A large amount of data in the form of recorded interviews, observations schedules and writing samples was collected.

Although it was initially believed that the NZCER would produce a paper on each of the studies by the end of 1988 this has not proved to be the case. To date only informal findings on each of the studies have been published except in the case of the following four studies.

- Study 9: The impact of micro-computers on teachers and on the observable behaviours of children aged four to seven years
- Study 10: Developing spatial relationships using Logo
- Study 12: Collaborative word processing
- Study 15: The computer as a diagnostic tool in mathematics

General conclusion from the exploratory studies

While the detailed report of the Research Council is not yet available for all of the studies, some preliminary findings have been reported both to the Minister of Education and in journal articles written by NZCER. The following conclusions are based on those articles, interviews with participating pupils and teachers, and informal observations of the researchers.

With very few exceptions the commitment of the teachers involved in these studies was very high. They responded positively to the opportunity to be involved, and contributed many hours of extra work in the evaluation of the study.

Other studies (eg Burnett et al, 1982) have shown that teacher style is a most important determinant in the successful implementation of educational computing in the classroom. A general conclusion of these studies would reinforce that view. Those teachers who operated successful activity centre based classrooms prior to the study experienced little difficulty in adapting to the introduction of a computer.

Many of the teachers reported that their classroom management style changed in order to accommodate children working with the computer and they expressed satisfaction at the outcome. Teachers who previously operated in a very teacher centred way reported greater difficulties adapting to the management of classroom which contained a computer, but were pleased with results once a more flexible attitude had been adopted.

Teachers agreed that a teacher centred learning environment was in conflict with successful learning at the computer. It was also agreed that children do make significant learning progress when working with ap-

propriate software at the computer.

Many of the studies involved the use of only one, or at most three, computers in individual classrooms. It was necessary for the teachers to develop strategies of classroom management which enabled successful use of a limited resource.

The ideal number of computers seemed to depend on both teacher style and the nature of the activities. However many of the teachers felt that about three computers in the room made the size of the groups involved in computer based activities 'worth planning for'.

Researchers noted that teachers with smaller classes generally experienced fewer management problems than those in larger classes, regardless of the age mix of the children. One related observation is that classroom computer use seems to be better facilitated in small rural schools than in larger urban schools.

In most of the studies teachers commented about these attitudes in the children:

- they felt positive about the many activities in which they were involved;
- they reported feeling a sense of independence when working at the computer;
- they expressed satisfaction in their ability to control the technology;
- they expressed a sense of achievement in the results.

The satisfaction with achieved results was particularly true in the case of some of the formerly reluctant writers using a word processor.

In nearly all studies, observers reported a higher than usual level of motivation in the children working at computers. In most cases the motivation levels remained high over the length of the studies. The children themselves generally reported enjoyment in using the computers, regardless of the activities in which they were involved.

An important parameter in the studies, was the question of gender equity in computer use. In the primary school classrooms participating in these studies, there have been few observable differences between the access to computers afforded to boys as compared to girls. Similarly no major differences have been observed between the uses made by girls and by boys. It must be noted, however, that there has been considerable teacher intervention in most of these studies to ensure equity of access.

In a number of studies, children's use of the computers in leisure time has been monitored. It has been discovered that in the absence of strict controls, leisure time use tends to be dominated by male students, and certain kinds of games, typically video games, tend to be favoured. Teachers have reported that girls' use of the computers in leisure time tends to focus on work completion and activities such as graphics production and word processing.

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In very many cases teachers reported increased or enthusiastic collaboration between students involved in cooperative activities such as shared writing and group decision making at the computer. It appeared that the computer screen provides an easily seen focus which binds the participants to a common purpose, encouraging them to interact in positive ways and to negotiate to achieve consensus. Many teachers have reported that children engaged in computer based activities initiate more task related conversations both with their peers and their teachers, than previously. Even formerly reticent students express ideas and opinions with more enthusiasm.

The word processing studies have shown that once students have become familiar with a word processor, they tend to write more than when using traditional pen and paper methods. Teachers consider that this is very important as students who may have been expected to write very little in a traditional setting are now not only writing, but writing a considerable amount and enjoying it. Most teachers also consider that the quality of the writing which the students produce is better. NZCER's detailed analyses of writing quality have yet to be completed.

Teachers have observed that children using a word processing program, are released from the drudgery of rewriting. They are also freed from limitations which may be imposed by their lack of fine motor skills. Thus students are encouraged to continue to edit pieces of work long after the penalty of rewriting with pen and paper would have persuaded them to give up. Teachers also believe that, individually, students bring a piece of work to publication standard much more quickly using the word processor than by traditional methods.

While using computer programs such as interactive fiction simulations, Logo, or graphics design programs, students are thrust into a variety of problem solving situations. As noted above, teachers have observed that children are likely to discuss possible approaches to the problems presented on the computer's screen.

One of the studies involved the use of electronic communications. The teachers observed that children have little difficulty in understanding and using electronic mail. Students are highly motivated to write when electronic publishing is possible. Teachers and students are excited about the opportunities for development of multi-cultural awareness, afforded by international exchange of letters, stories and information of interest to the students.

The electronic mail part of this study has had a significant impact outside of the study. A great many schools, both primary and secondary, are now exchanging information via electronic mail. Recently a national schools' newspaper was produced from contributions submitted by schools both within and outside of New Zealand via electronic mail.

Three of the four special education studies have shown that disabled and handicapped students benefit greatly from the advantages of using computers to perform learning tasks. For example one study has shown that partially sighted students who formerly had great difficulty writing independently have been enabled by appropriate word processing software to write and publish as well as their normally sighted peers. Similarly, ap-

propriate computer software has enabled deaf students to easily experience patterns of interactive communication otherwise very difficult for them. Teachers report that the language development of hearing impaired students is significantly faster as a result of the computer use.

In all cases teachers report that children learned to cope with the computers very quickly. It is reported that children feel confident in their ability to control the computer and have a good appreciation of what they can make it do. In most cases this 'computer awareness' has grown from children's everyday use of the equipment.

A key question being answered by any evaluation of educational computing is whether the learning achieved by a child in a computer-aided environment is transferable to a "non-computer" environment. Some educators have argued that the real potential of computers in education lies in the way they extend children's powers - their creative powers, their thinking powers, and their computational powers.

Conclusions from studies

Regardless of any policy directions which may derive from the Exploratory Studies in Educational Computing as a whole, the studies will have had an enormous impact. They provide models for what are, in our present state of knowledge, the most potentially useful classroom computer activities. The experience of the teachers and children will be widely reported. Not the least of the benefits from the studies will be the emergence of a number of focus schools, and the development of a sizeable body of teachers in New Zealand who will now be able to draw on a valuable background of experience in educational computing.

Already a second phase of studies has been embarked upon. Schools have been invited to submit proposals for 'action research' projects which aim to further our understanding of some of the issues raised by the exploratory studies. Equity has been a strong determinant in the selection of the schools for these projects. Most of the schools involved have little or no previous computer experience for various reasons. This factor alone will make the outcome of these projects of considerable interest.

The results of the exploratory studies, building as they do on informal observations of good classroom practice, have encouraged the Ministry of Education to continue to foster the use of computers in schools and early childhood centres. In the meantime, the major thrust will continue to be encouragement of the use of computers in language development and other cross curriculum activities.

Freyberg integrated studies project

A large scale, 4 years, school-based curriculum development and research project - the Freyberg Integrated Studies Project - was recently completed. The project developed programmes which incorporated three curriculum design elements:

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- educational out of class activities
- students use of the computer as an information processing and analysis tool
- integrated approaches to teaching and learning.

The uniqueness of the project lay not in an attempt to recreate the curriculum of schools or to create a new set of knowledge disciplines but in its pedagogical principles and its integrated curriculum model.

The computer performed several roles:

- a tool for communication and learning (used by the students to solve problems, apply and develop skills and knowledge drawn from subjects of the core curriculum and interrelate these subjects in the study of real life issues and problems)
- a medium which permitted practical applications
- a facilitator of knowledge integration.

A good example of how the computer was integrated into the curriculum is provided by the programme of a non-School Certificate class. Within the programme, teachers of Mathematics, English and Science collaborated with researchers to develop a unit of work on Ergonomics and Health Education. The common theme of the non-certificate students and teachers was cooperation and taking responsibility for one's own learning as students developed a division of labour to accomplish assigned tasks of data collection and data analysis using computers. Doing the programme required the practical application of knowledge and skills drawn from a number of subjects and this in turn required that students make connections between subjects, e.g. Mathematics, English and Social Studies.

There were two noticeable outcomes:

- a significant improvement in the attitudes and performance of the fifth formers
- the conversion of a sceptical mathematics teacher to the value of integrated teaching and learning.

Conclusions

In summary, when all three curriculum design elements were being employed they constituted a dynamic educational system. Each element provided a means of applying key pedagogical principles and strategies.

A comprehensive research programme gathered data and investigated all aspects of the project throughout its four year term. The aspects included, classroom dynamics, student attitude, motivation and performance, professional development of teachers, and computer use and its effects. This information has been progressively analysed and reported in professional

and educational research journals.

Generally, both students and teachers consistently reported out of class activities to be highly motivating and rewarding. There was a similar response to computer use. This research also demonstrated that where the Integrated Studies were most consistently used they were well liked by the students.

While more boys (53%) than girls (27%) had access to computers at home there was still no significant difference in computer use at school between girls and boys within either integrated studies classes or the control class. Within the integrated studies programme, girls tended to have higher job aspirations than boys and in both the Integrated Studies classes and the control class, girls had higher educational aspirations than boys. Although there was no significant difference, both boys and girls believed that learning to use computer applications would enhance their educational performance and the chances of getting a preferred occupation.

The integrated curriculum, but especially the out-of class activities and computer use aspects, created an environment in which teachers acquired and used a range of teaching techniques and management methods more extensive than the ones which secondary teachers appear to use commonly. As the teachers became more confident and competent, they began to work much more with, and alongside, students on an individual basis. That is to say, the teachers shifted away from their traditional, instructional role definitions in favour of becoming organisers and facilitators of learning. For both students and teachers the relationship became more demanding but at the same time produced high job satisfaction for the teachers, and high interest and application for the students.

The Freyberg Integrated Studies Project demonstrated ways in which the computer can be employed as a valuable teaching and learning resource in secondary education. Education with computers is feasible within the traditional, compartmentalized curricula. Within the integrated approach, however, students are progressively gaining knowledge of and mastery over integrated computer applications as they use them to solve practical problems and address real life issues. Experiences to date indicate that the use of computer applications facilitates linking between and the integration of subjects.

This development is significant at the present time in New Zealand when there is strong community and government support for the implementation of alternative teaching methods and new technologies that will improve the quality of education. The project reported here demonstrated the feasibility of curriculum integration as a viable alternative approach.

There is some indication that project experience and research will demonstrate the educational effectiveness of curriculum integration as well. In this event, education with computers will have an increasingly important role to play in the enhancement of student learning both within subjects and across the curriculum. Computer technology may yet come into its own as a key educational resource, assisting all students to understand inter-relationships between subjects and comprehend how they fit within the whole complex of knowledge.

Philippines

Introduction

The Philippines is clearly not a computer-based information society and has yet to attain a high technology state wherein the predominant workforce is engaged in information systems based on computers. However, world-wide concerns regarding the development of information and computer technology professionals make the use of computers in education relevant (Teodoro, 1989). The high literacy rate of Filipinos (88%), would also account for the desire of the people to become equally literate in computers.

The Philippine government authorities were fully aware of the significance of computer and information technology, and so created the Information Technology Coordinating Council (ITCC). The move was a result of the plan prepared by an ad hoc Cabinet Assistance System committee under the Office of the President. The council is commissioned to exploit computer and information technology as a tool to hasten national development (National Information Technology Plan (NITP): 1989).

To attain the projected growth rate of 8.5% GNP in 1992, industry groups were prioritized by the government on the premise that these will yield maximum socio-economic benefits with a minimum infusion of additional investment and use of available technology. The computer software industry was one of those considered to carry high domestic and export market.

Use of Computers in Philippine Education System

In the 1950's and the 1960's, the use of computers in the Philippines was initiated by the business sector and training in computers was conducted by hardware suppliers like NCR Philippines, IBM Philippines, and Burroughs. In mid 1960's, computer training centers started offering short term computer courses in fundamentals of electronic data processing, programming and computer operations (keypunching, etc.).

In early 1970's, some universities and colleges made initial attempts in introducing computers as electives in business and commerce courses, and in the mid 1970's, degree programs in Computer Science and Computer Engineering were offered with limited enrolment in state universities and colleges (SUCs) like Polytechnic University of the Philippines (P.U.P.), University of the Philippines (U.P.), Rizal Technological College (R.T.C.) and Pamantasan ng Lungsod ng Manila (P.L.M), and by private universities and colleges like the Ateneo de Manila University (ADMU), DeLa Salle University, Mapua Institute of Technology (MIT), etc.

Computer education and/or training in the Philippines are available from four types of institutions: (1) universities and colleges, (2) private non-formal EDP schools, (3) computer suppliers, and (4) end-users (including service bureaus).

In the vicinity of formal education, there are now at least 12 colleges and universities that offer undergraduate programs in computer science, computer engineering or information systems or some combination of computer science and information systems and data processing and management.

The private non-formal EDP schools are training centers which offer short-term skill-building courses such as programming, systems analysis and design, and computer maintenance. Today, there are more than a hundred of these centers throughout the country.

The computer suppliers, on another hand, are confined only to offering training and orientation on programming languages, operating systems, computer operations and maintenance of their respective products.

Some government agencies and large private firms conduct their own in-house training programs for their personnel. Among the usual courses offered are programming, systems analysis and design, computer operations, methods and procedures of the hardware they have acquired.

Generally, the traditional educational and training services have not been sufficient to meet the industry's demands. While quite a large number take up these degree programs and training courses, their job preparedness and employment are not assured. Market demand for computer personnel has outpaced the production of qualified professionals. (NITP: Status of Information Technology in the Philippines, 1989).

Based on the 1988 National Computer Center IT Survey, state universities and colleges (SUCs) made a good showing in percentage number of users and computer density by ranking second over all government sub-sectors. However, most of the systems reported were microcomputers and only one each of minis and mainframes. In terms of percentage of use by sector, state colleges and universities ranked second with 34 users out of 39 respondents (87%). When it comes to computer density, state colleges and universities ranked second with 377 distributed among 34 users or a density of 11.09 systems per school.

Computers are used in an educational institution in a variety of ways, among which are administrative functions, academic management and instructional support. Computers are used in effectively handling the enrollment and registration systems, grading system, student accounts and the traditional accounting applications like general ledger, payroll, inventory, etc.

In the area of academic management, computers are used to schedule subjects and room offerings, keep track of faculty information system and the student information system. Very few have attempted to do this yet.

For instructional support, computers which are kept in laboratory rooms service students' hands-on needs for a clearer understanding and appreciation of data entry and controlling, programming, data base management systems, operating systems and similar topics.

Use of computers in the Philippines can be also viewed on the magnitude of its utility by elementary schools, secondary schools and tertiary schools. Private elementary schools, usually situated in Metropolitan Manila, enjoy the luxury of being able to offer students computer courses and facilities. Public elementary schools normally are not equipped with computer facilities, even although the Bureau of Elementary Education of the Department of Education, Culture and Sports has expressed the need for introducing computers in the elementary level. Secondary schools, public and private

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share also relatively the same experience. Computer courses are integrated usually in the practical arts subject in high school. It is in the colleges and universities that computers are utilized to the greatest extent possible. It is to be noted that the colleges and universities in Metropolitan Manila have an edge over those in sub-urban and rural areas due to communication and telecommunication limitations. Table 1 shows the coverage of computer education and training courses in the Philippines.

Government Regulation of Computer and Information Technology

The government, even in the early 70's, had realized the importance of computers in education. It required the National Computer Center to assist in the training of EDP trainers. Letters of instructions and executive orders were passed to regulate computers in education courses. The Department of Education, Culture and Sports (DECS) had issued orders regulating operations of computer training centers (CTC's) offering short-term computer courses.

Recognizing the role of computer and information technology in the country's total development, President Corazon C. Aquino issued an executive order in 1989 declaring June of every year as Information Technology Month. Also in 1989, the National Information Technology Plan was issued.

Dr. Willian Torres, in his keynote speech during the Executive Conference on Information Technology Education (EXCITE 1990) held last April 27 and 28, 1990 sponsored by the Department of Education, Culture and Sports (DECS) said that schools and individuals have gone into computer education and training without really putting much thought to the kind of programs they offer nor their capability for such offerings.

The demand to produce quality computer and information professionals prompted the DECS through its Bureau of Higher Education (BHE) to create a Technical Panel for Information Technology Education (TPITE) involving experts from government and non-government agencies concerned. The TPITE will assist the DECS particularly the BHE to play a vital pro-active role in computer training and education. The EXCITE 1990 mentioned above was held in consonance with the proposal of the members of the TPITE to come up with a conference which will focus on trends, developments and directions in computer and information technology. The outputs of the gathering will be inputs to the Technical Panel in its deliberations about computer and IT education.

Table 1
Coverage of Computer Education and Training Courses

Level	Type	Coverage
Pre-school	Private	* Games and tutorials
Elementary	Public	* Generally new especially in rural areas and provinces

Level	Type	Coverage
Elementary	Public	* In Metro Manila and major cities introductory courses and tutorials as in IBM Pilot project at Pinyaha Elementary school in Mezon City
	Private	* Computer Literacy * Tutorials - Math, Spelling, etc.
Secondary	Public	* Not yet offered in the provinces * In Metro Manila and major cities, integrated in Practical Arts (Computer Literacy, Software Packages and BASIC language)
	Private	* In Metro Manila and other major cities, integrated in Practical Arts (Computer Literacy, Software Packages and BASIC language) * Seldom offered in rural areas
Vocational - Technical	Public and Private	* Offer practically all computer courses, introductory and advanced
Tertiary	Public and State colleges/ universities and Private	* All tertiary schools required to offer the mandatory three units general education Computers in Society subject * DECS order No.5 requires mandatory 12 units of computer subjects in Bachelor of Science in Accountancy Curriculum * Table 2 lists the computer degree programs and courses in Philippine colleges and universities
	State colleges/ universities and Private	* Master of Science in Computer Science * Master of Science in Computer Application * Master in Science Teaching Major in Computer Technology * Master in Business Administration, major in Management Information System

Degree Computer Programs Offered in Philippine Colleges and Universities

- * Bachelor of Science in Computer Science
- * Bachelor in Information Technology
- * Bachelor of Science in Management Information System
- * Bachelor in Computer Data Processing Management
- * Bachelor of Science in Computer Engineering
- * Bachelor of Science in Mathematics Major in Computer Science
- * One year Post-Baccalaureate Diploma in Computer Technology

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Problems and Issues

Dr. Macaballug (1989) enumerated the following problems of use of computers in an institution of higher learning:

1. lack of qualified and well-trained faculty
2. faculty and staff development
3. transfer of faculty to industry/brain drain
4. laboratory equipment and facilities
5. library resources
6. research and extension services
7. financial and technical constraints

Dr. Macaballug offered the following recommendations to solve the problems cited:

1. improved faculty training systems
2. staff development program
3. an incentive program to arrest the problem of transfer of faculty to industry
4. Budget constraints solutions
 - a. workable cost-efficient methods to set up/acquire laboratory facilities
 - b. establish local fabrication centers
 - c. industry-education cooperation program
5. library resources improvement through donations and fund-raising campaigns
6. sourcing for funds
 - a. income-generating projects
 - b. present projects to funding foreign institutions like JICA, UNDP, UNESCO and to local agencies like Department of Science and Technology (DOST)
 - c. establish good relations with industry
 - d. organize consortiums and resource-sharing agreements

Dr. Carague (1989) enumerated the following problems and issues pertaining to computer education in state universities and colleges (SUCs):

1. equipment acquisition
2. faculty development
3. courseware
4. funding
5. enforcement of government orders
6. lack of support from administrators

She gave the following recommendations:

1. faculty development programs
2. curriculum
3. government support
4. government agencies
5. allocation of funds
6. tie-ups
7. research

8. use of media
9. student activities

Researcher identified the same problems and issues and gave recommendations on how such can be remedied.

Torres (1989) summed up the issues and problems as follows:

1. Lack of faculty, particularly for advanced courses.
2. Lack of computer facilities, compounded by concentration of these facilities in Metropolitan Manila.
3. Lack of opportunities (financial and otherwise) within the local setting.
4. Almost total dependence on imported equipment, software and even books and materials.
5. Need to improve quality control measures, especially for non-degree courses.

Trends in Computers in Education in the Philippines

1. Flourishing software industry: there is a world-wide demand for software products, which the Filipino can ably develop.
2. Professionalisation of Computer Degree Education: the National Information Technology Plan brought about the need for the Technical Panel for Information Technology Education (TPITE) which will look into the professionalisation of computer and IT education in the Philippines.
3. Proliferation of Computer Training Centers (CTCs): private computer training centers (CTC's) are mushrooming, CTC's usually produce substandard graduates.
4. Industry education cooperation program: initiated by the Philippine Computer Society, it will engage faculty and students to do practicum with industry.
5. Formation of computer organizations and society like Philippine Computer Society (PCS), Philippine State Universities and Colleges Computer Education and Society (PSUCCESS), Government Organization for Information Technology (GOIT), etc. which are aimed at promoting and developing computer and information technology in the country.
6. Use of computers in elementary and secondary levels is gaining support of the government and school administrators.
7. The National Information Technology Plan (NITP) provides directions for use of computers in education.

Bondoc, in his concluding remarks during the EXCITE 1990 convention happily noted that unlike other courses, there is an effective demand for graduates in computer and IT courses. He mentioned the statement of Gus

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Lagman, the president of the Philippine Computer Society, that the US 300 million dollar target in software export of the country by 1992 need 15,000 software professionals. On top of this are the demand from other local and international industries. It is believed that if this is properly responded to, it will be a tremendous boost to the sagging economy of the Philippines.

Computers are now playing an active role in the Philippine educational system. With the cost becoming more affordable, especially for micros, computers are now within the reach of students at all levels of education from elementary to tertiary. Computer applications are being used, on microcomputers, for administrative, academic and instructional purposes.

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Republic of Korea

Part A

I. State of Art

It is generally accepted that hardware provision, quality software development, and staff development are the keys to the success of school computer education. Since 1987, the Korean Ministry of Education has been implementing its policy based on "the Computer Education Reinforcement Plan". As a result, 77% of Korean schools have more than one computer, 20% of teachers have been trained, and each school has an average of 1.72 diskettes of educational software, as of July 1989. This figure clearly shows that development of educational software has been neglected by policy makers. It goes without saying that hardware installation and teacher training are critical factors for implementing computer education. Many critics, however, point out that quality software is urgently needed in schools, considering that hardware and teachers have been prepared, and that the school computer curriculum has been developed.

Development of educational software is still in its infancy in Korea. Generally speaking, three parties participate in the development of educational software in Korea. First, government, universities, and research institutes are developing software to enhance the teaching-learning process, using public funds. Second, small software houses are developing educational software without the participation of educational specialists. Third, hardware makers are developing educational software in order to promote their product sales. They usually commission individuals or small software houses to develop educational software. This practice may be construed as the hardware-driven mentality.

In short, foundations of development are not yet solidly laid. This inhibits the production and dissemination of a wide range of appropriate educational software.

Educational software now being used in Korean schools has been developed by private companies, KEDI, teachers themselves, and others, and the percentages which each part accounts for are 35.1%, 33.3%, 11.5%, and 17.1%, respectively.

Table 1: Rate of Educational Software in Schools by Developer

Developer	unit: %			
	Elementary	Middle	High	Total
Teachers	12.05	9.75	25.46	14.19
KEDI	43.54	21.98	6.06	33.29
Private company	27.30	51.91	50.77	35.08
Others	17.11	16.36	17.72	17.17

As pointed out above, each school has only 1.72 diskettes of educational software. This low rate of holding software is ascribed not only to the fact that the amount of developed software is so small, but also to the fact that educational software developed by KEDI has been distributed only

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to the local board of education. It is the local board of education that has the responsibility for disseminating it to schools. Thus, sometimes teachers who wish to use software in their classrooms have difficulty in securing it. This tells us that the dissemination policy is as important as the development policy.

Classroom implementation of educational software is influenced by many factors, such as hardware, curriculum, resource personnel, and necessary peripherals. Under the circumstances, with the low level of dissemination and the small amount of educational software available, it is difficult for teachers to use computers effectively in their classrooms. Poor as the circumstances may be, it is very encouraging that more and more teachers are getting involved in the use of computers in their teaching activities. It is crucial that we now prepare more detailed strategies for classroom implementation of educational software.

II. Present Tasks and Alternative Strategies

1. On Development

In Korea, educational software is being developed for two different purposes. First, most hardware makers develop it to accelerate hardware dissemination. Second, public institutes develop it to improve instructional effectiveness. But the first is criticized for the poor quality of the programs which are usually just like page-turners. The second is criticized on educational grounds because it does not consider the school situation.

The educational software to be developed in the future should tailor itself to facilitating students' self-paced learning, creative thinking, and problem solving ability needed in an information society. Also educational software should aid teaching activities and focus on compensating teachers' weakness.

1) Development strategy

Educational software, especially courseware, needs to be developed in various formats, which consider the characteristics of the learner, the instructor, and their interaction. To develop educational software to meet these needs requires the participation of educational experts, among others, in assessing and analyzing the needs and problems concerned.

2) User and types of educational software

Up to now, educational software has been developed to assist students' independent study and individualized learning in overcrowded classrooms. In Korea, each school has had and will have 31 personal computers by 1996. This will allow two students to share one computer in classroom. And also, in the near future, education through computer communication will be commenced. Therefore, in developing educational software we have to consider not only learners' characteristics but also learning mode such as by individual, by group, or through a network system.

3) Quality management

It is desirable for both individuals and companies to develop a variety of educational software. It may give impetus to the development of educational software, but it is not advisable to leave educational software to the free market system. In this regard, a system of educational software quality assurance or an evaluation system needs to be established.

2. On Dissemination

1) Information service system

We do not have an information service system of educational software. Especially in rural areas, it is hard to know what kinds of, when, and how many educational software package have been developed. Therefore, we need to publish an annual document which lists not only the title, contents, and developer, but also features a user's guide and opinions of experts on educational software. When we disseminate this type of systematic information we can ensure that there is an increasing awareness of good educational software and so help users to select and use appropriate materials.

2) Dissemination system

At present, there are two main dissemination systems in Korea. One is the free dissemination by the Ministry of Education and Board of Education, and the other is the charged dissemination mostly by computer hardware manufacturers. Also we have a small range of dissemination by software houses. The dissemination of educational software financed by the government is now limited to schools. It is recommended that the government's funded software should be made available to the general public.

3) Price

The price of educational software depends on the free market system in principle, but it is desirable to disseminate educational software at a low price to promote its use. At the moment computer-related materials (i.e. floppy disks) are more expensive than other instructional materials. This can lead to educational inequality. In addition, the high price of educational software restricts its dissemination and implementation. To promote software development, we need to assure manufacturers of a reasonable rate of return. In this connection, it is necessary to decrease the price of educational software in order to promote its implementation. A compromise must be reached which will meet both these needs.

3. On Classroom Use

1) Objectives

The objectives for using computers in school are two-fold. One is as a tool for effective teaching-learning and the other is as a support system

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for school management. Shown in Table 2, the quantity of management applications software is less than CAI programs.

Table 2: Number and types of Educational Software

School	Teaching-learning (CAI)	Management applications	Total
Elementary	10,533	2,511	13,044
Middle	1,830	956	2,786
High	2,216	2,324	4,540
Total	14,579 (N=8,479)	5,791 (N=1,118)	20,370

Computers can also be used for hobby and extra-curricular activities. Many people believe that educational software is just for curricular activities, but we believe that both uses are valid. We now need to develop a range of educational software for extra-curricular activity and for studying at home. Especially, we need to expand educational software to encompass computer managed programs for aiding teachers, such as curriculum development, instructional design, students' record keeping, and school administration.

2) Methods

We have a high expectation of teachers' and leaders' roles in effective use of computers for improving students' achievements. It is sometimes thought that the main quality of a computer teacher should be to have special knowledge and skills related to computers, but it is surely more important to have a general comprehension of the information society and a positive attitude towards improving students' abilities. Also it is important to use correct methods and teach appropriate content at every stage of students' mental and physical development. Therefore, there are differences in objectives and methods according to school grade levels. For example, in elementary school students need to become familiar with computers and acquire good habits through frequent computer use. In middle school, students need to use computer for learning and actively acquire computer related knowledge and skills. In senior high school, students can be recommended to study the computer as an elective course and become involved in programming in depth.

3) Time and place

There is no restriction of time and place in using educational software. But, in Korea, the use of computers in school is restricted to the computer lab. As Table 3 shows, most periods for using software are after school, except in high school.

Table 3: Use of Educational Software

Use	unit: %			
	Elementary	Middle	High	Total
In class	25.3 (0.24)	10.7 (0.08)	65.8 (2.02)	38.0 (0.46)
Extra-curricular	24.2 (0.23)	37.3 (0.28)	12.4 (0.38)	21.5 (0.26)
After school	50.5 (0.48)	52.0 (0.39)	21.8 (0.67)	40.5 (0.49)
Total	100.0 (0.95)	100.0 (0.75)	100.0 (3.07)	100.0 (1.21)

* The figure in parenthesis indicates the hours of use per week.

The need to use computers is increasing in various areas. For Example, some of the main areas of computer use are:

- E computer games in leisure time;
- E library database;
- E career counseling;
- E gaining access to specific information; and
- E providing a source of evaluation information.

Students should be able to use computers whenever the need arises. The time when computers are available to them should be extended, appropriate software should be developed and adequate support given.

4) Others

Educational software is expected to increase rapidly. Schools need to plan for the maintenance and operation of floppy diskettes. School administrators need to give priority to meeting teachers' and students' needs in relation to the use of educational software.

III. Conclusions

1. Recommendations

1) Development

The most important element in the implementation of effective school computer education is the development and distributing of quality educational software in the Korean context. To this end, it is necessary to establish general guidelines for the development of quality software suitable for the Korean situation. To achieve this goal, the following recommendations are suggested:

First, considering that the software development budget is equal to only 4% of hardware distribution budget, more investment on development of educational software should be made.

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Second, incentives should be created to induce private companies to develop educational software at a greatly accelerated rate. This may include such policies as offering development funding and exempting taxes.

Third, authoring tools for teachers should be developed so that teachers can easily develop their own courseware according to their needs. There are already several authoring tools used by some CAI developers in Korea. They, however, are not suitable for teacher's authoring in terms of hardware used in schools.

Finally, it is recommended that basic research into educational software development should be strengthened. Such research should focus on instructional design, courseware model development and courseware implementation.

2) Dissemination

Educational software is dissemination in Korea in two ways: schools acquire software free of charge from the government and they pay for software from other sources. Dissemination should now be rationalised.

A system should be established by which users can buy educational software developed by the government. This will enable students to use quality educational software outside school computer laboratories, and will accelerate the implementation of computer use in education.

3) Classroom use

As mentioned above, classroom implementation is as important as quality software development for effective computer education. The following suggestion are made relating to classroom implementation.

First, teacher training needs to be reoriented from focusing on teaching computer language to teaching how to use software in classrooms.

Second, a software library should be established. This library will collect and distribute printed materials as well as educational software, thus facilitating the classroom use of computers.

2. Future of Educational Software

The following projections are made for the future of educational software in Korea.

First, there will be a radical change in teaching-learning methods and processes through the introduction and use of educational software. The teacher's role is expected to change from an authoritative knowledge deliverer to a guide of student's learning.

Second, content-free software for improving thinking skills will be developed increasingly. This will focus on skills such as creative thinking.

problem solving and logical thinking.

Third, educational software will be integrated with many other technologies such as video disk and communication devices.

Finally, the newest technology in computer science, such as AI including expert system, will be harnessed for courseware development. This will bring about individualized instruction which encompasses individual differences in learning style, learning pace, and even the range of learning experience of students.

Part B

I. Establishment of National Policy in "Computer Education"

The following factors inform and provide a framework for the establishment of a National Policy:

1. Awareness of Needs for "Computer Education"

A. Expected social change

- 1) Information society
 - a. Information is the source of national wealth
 - b. Necessary to the advancement of the country
- 2) Science and technology oriented society
 - a. Increase of science-technology industry
 - b. Increased international competition in the science-technology area
- 3) Computer oriented society
 - a. Increase of computer provision
 - b. National computer network formation
 - c. Daily use of computers

B. Educational Tasks

- 1) Manpower development for information industry
- 2) Enlightenment of science-technology education
- 3) Universalization of computer-literacy education

C. Direction

The need to strengthen computer education in all levels of schools.

2. Tasks to be accomplished in order to implement "Computer Education"

A. Main problems

- 1) Insufficient educational opportunity
 - a. incomplete educational curriculum
 - b. lack of educational materials and resources
 - c. inadequate educational environment
- 2) Insufficient provision of computers
 - a. insufficient quantity
 - b. insufficient peripherals for adequate software use
 - c. lack of proper maintenance
- 3) Insufficient software

- a. poor quantity and quality
 - b. poor software development and distribution system
 - c. lack of software evaluation mechanism
- 4) Lack of trained teachers
- a. not enough in-service training opportunity
 - b. insufficient pre-service training for computer teachers
 - c. insufficient training materials
- 5) Lack of administrative-budgetary support system
- a. not enough awareness of the importance of computer education
 - b. shortage of experts
 - c. lack of research in the area
 - d. shortage of financial resources
 - e. lack of cooperation between industry and academic institutions

B. Solutions

The solution to these problems lies in:

- increasing the availability of human and material resources;
- improving and extending the curriculum;
- establishing a unit for research and development;
- setting up a center for the production and evaluation of courseware; and
- increasing the provision of pre-service and in-service training of teachers.

3. Computer Education Implementation Strategies

A. Purpose of computer education for schools

To establish general computer use in school communities and to prepare students for participation in the information society.

B. General direction

- 1) Enlarge computer education opportunities
- 2) Increase computer assisted instructional method
- 3) Increase the use of computers in school administration

C. Tasks

1) Establishment of Computer Education Objectives

- a) Objectives of elementary schools
 - Develop familiarity with computers
 - Experience computer operation
 - Understand basic concept of programming

- b) Objectives for middle schools

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- Understand computer structure and functions
- Increase computer operation skills
- Understand the relationship between work and computers
- Acquire basic programming skill

c) Objectives for high schools

- Understand basic principles of computers
- Understand the relationship between society and computers
- Increase the skills of computer use

II. Responsible organizations

A. Government

- 1) MOE (Ministry of Education) and KEDI (Korean Educational Development Institute)
 - software development ('96) total 459 units
- 2) MO (Ministry of Communication), KTA (Korean Telecommunication Agency) and ICC (Information Culture Center)
 - hardware provision
 - development of educational database ('93) - on-line homestudy program
 - establish national computer network
- 3) MOST (Ministry of Science and Technology) and SERI (System Engineering Research Institute)
 - CBE program development

B. Universities

- 1) Hanyang Univ. (Center for Educational Computers)
 - develop CAI/CAL coursewares
 - develop interactive video disc programs
 - conduct research related to the effectiveness of various mode of CAI/CAL materials
 - hold international/national seminars/conferences on computer education

C. Industry and private firms

- develop authoring tool
- develop CAI materials

III. Budget Support Plan

Table 1: Budget Support Plan for Computer Education

(unit: 100 million won)

		'89	'90	'91	'92	'93	'94	'95	'96	Total
Hardware	Elementary	60.0	80.0	80.0	80.0	80.0	80.0	80.0	112.2	652.2
	Middle	33.6	40.1	40.2	40.2	40.0	40.1	40.2	39.6	314.0
	High	3.2	18.4	18.3	18.3	18.8	18.3	18.3	16.4	130.0
	Teacher training institute	1.68	1.92	-	-	-	-	-	-	3.6
	Subtotal	98.48	140.42	138.50	138.50	138.50	138.40	138.50	168.20	1,099.80
Software	Software	1.78	4.00	4.32	4.64	4.50	4.25	3.70	3.55	30.74
	Basic research	-	1.00	1.00	1.00	1.00	1.00	1.00	1.00	7.00
	Distribution	0.27	1.36	2.75	4.34	5.74	7.45	8.67	11.94	42.52
	Subtotal	2.05	6.36	8.07	9.98	11.24	12.70	13.37	16.49	80.26
Teacher training	Elementary	0.96	4.74	4.74	4.74	4.74	4.74	4.74	4.74	34.14
	Middle	0.37	0.69	0.69	0.69	0.69	0.69	0.69	0.69	5.20
	High	0.23	0.81	0.81	0.81	0.81	0.81	0.81	0.81	5.90
	Foreign training	-	0.6	0.6	0.6	0.6	0.6	0.6	0.6	4.20
	Subtotal	1.56	6.84	6.84	6.84	6.84	6.84	6.84	6.84	49.44
Experimental School		-	0.18	0.18	0.18	0.18	0.18	0.18	0.18	1.26
Total		102.09	153.80	153.59	155.50	157.06	158.12	158.89	191.71	1,230.76

Table 2: Computer Education Support Plan for '90

(unit: million won)

	Elementary	Middle	High	Total
No. of Hardware (budget)	15,983 (8,000)	7,690 (4,012)	3,658 (1,841)	27,341 (13,853)
No. of Software units (budget)	24 (200)	20 (158.4)	15 (96)	59 (151.4)
No. of trained teachers (budget)	7,904 (474)	1,144 (69)	1,352 (81)	10,400 (624)

Singapore

Introduction

The arrival of the microcomputer in education has brought another dimension to teaching and learning in Singapore schools. The Ministry of Education recognises the great potential of computers in education and since 1981 several programmes involving the use of computers have been implemented in our secondary schools and junior colleges. Also, a Computer-Based Learning (CBL) Project Team was formed in 1983 with the aim of investigating appropriate ways of using the computer to facilitate teaching and learning.

Computer Education in Primary Schools

The Computer-Based Learning (CBL) Project Team launched a 3-year longitudinal study to evaluate the effectiveness of using the computer for Mathematics learning at the primary level and to develop courseware for implementation. In addition, a Computer-Assisted Remediation Programme and a Computer-Based Enrichment Programme were carried out in some schools.

The 3-year longitudinal study has shown that pupils learned more effectively and efficiently with the use of the computer. The study also found that pupils who worked with the computer, in particular the weaker pupils, did much better than their counterparts who did not use the computer. An invaluable outcome of the 3-year longitudinal study is the development of courseware specially designed to integrate with the Primary Mathematics instruction materials published by the Ministry. This courseware has been published and is available to schools.

The Computer-Assisted Remediation Programme was carried out in several schools with the aim of using the microcomputer to aid small-group remediation in Mathematics. The results of this study indicated that both pupil achievement and attitude towards Mathematics improved after the programme.

The Computer-Based Enrichment Programme was carried out in some schools. This programme provided pupils in the upper primary level with computer-based activities that facilitate development of problem-solving, analytical thinking and information processing skills.

Computer Education in Secondary Schools

1) Computer Appreciation Clubs

A Computer Appreciation Course for secondary schools has been provided for pupils since 1981. All 141 secondary schools have set up Computer Appreciation Clubs (CAČs) to conduct the course as one of their extra-curricular activities.

The objectives of the Computer Appreciation Course are:

- a) To stimulate and develop pupils' interest in computers and their

applications

- b) To impart some knowledge of computer programming to pupils so that they can write simple programs on microcomputers

Since 1980, the Ministry has trained more than 1,000 teachers through part-time in-service courses on computer appreciation. The teachers were taught BASIC programming, Logo Programming, dBase III and WordStar. The teachers are specially trained to take charge of the CACs in their schools.

Each secondary school is provided with a minimum of six microcomputers for conducting computer appreciation courses for pupils.

2) Computer Literacy Programme

The Computer Literacy Programme was introduced to schools in 1989. Its objective is to enable all pupils of a particular level (secondary 2) to use at least one computer software package to facilitate writing or computing. The Ministry has developed a package entitled "Learning and Writing with the Computer", to help schools implement this computer literacy programme. This package contains lessons in English Language, History and Geography and it teaches pupils how to use word processing software for process writing.

A Computer Literacy Course was specially designed for teachers teaching the humanities to enable them to conduct this computer literacy programme. It is a 15-hour part-time in-service course.

The Ministry of Education provides schools with up to 10 computers to facilitate the implementation of the computer literacy programme.

Computer Education in Junior Colleges and Pre-U Institutes

1) A-Level Computer Science

The A-level Computer Science course is offered as one of the formal curriculum subjects in all junior colleges. The Cambridge General Certificate of Education (GCE) advanced Level Syllabus is adopted.

The objectives of the course are:

- a) To provide a good foundation for students who will continue to study Computer Science in universities and other institutes of higher learning.
- b) To develop in students an understanding of how computing is used in various fields, such as Industry, Commerce, Science & Public Administration.
- c) To provide a working knowledge in computing to those who will take up careers in the computing and data processing industries.

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Each junior college is provided with a computer laboratory with a local area network system of microcomputers. Junior colleges with a bigger computer science enrolment are provided with 21 workstations while those with a smaller enrolment are provided with 14 workstations.

2) Computer Literacy Programme

The Computer Literacy Programme for all Pre-University students has been implemented since 1988. Every student goes through a 5-hour computer literacy course which is conducted outside the curriculum. The junior colleges and Pre-University institutes are also encouraged to conduct other courses on word processing, desktop publishing, spreadsheets and data processing if time and manpower are available.

The objectives of the programme are:

- a) to familiarise students with computers, and
- b) to enable students to use the microcomputer for word processing, data processing and for preparing spreadsheets.

Each junior college is equipped with a computer laboratory with 25 microcomputers while that for each Pre-University institute is equipped with 20 microcomputers.

School Link Project

The School Link Project is a computer networking project that links up the Ministry of Education headquarters to all the 350 schools in Singapore. The aims of the project are to assist schools in their administration and to improve communication between schools and headquarters. The project costs S\$17.18m (or US\$9.45 million) and is jointly developed by the Ministry of Education and the National Computer Board of Singapore.

1) School Link Application Systems

Seven application systems were identified under this project:

- (a) Pupil Management System: This system assists schools in their management and processing of pupil data and provides easy feedback to the central, Pupil Data Bank at headquarters. The system has a local data containing particulars of all its pupils and their parents. The system also captures pupils' examination results, processes them and prints performance reports for each pupil, class and standard. The pupil data is then transferred up to the host mainframe for further use by the headquarters and the government.
- (b) Office System: This system provides word processing and electronic mailing functions.

- (c) Financial System: This system assists schools in recording and tracking their income and expenditures. The records are further processed and tracked by the Ministry headquarters.
- (d) School Library System: This system provides cataloguing facilities and recording of book loans.
- (e) School Scheduling System: This system assists school administrators in generating suitable time-tables for each class and teacher in the school. The data can then be transferred to the host mainframe for central planning and monitoring purposes at headquarters.
- (f) School Item Pool System: This system assists teachers in setting quality tests for pupils and enables teachers to share their question items.
- (g) School Inventory System: This system assists school in recording and tracking the inventory of their equipment.

2) School Link Network

The School Link network consists of a wide-area network linking microcomputers in schools to a IBM 3083 mainframe at the Ministry headquarters. Each school is provided with a set of IBM PC/AT or its compatible for the link-up. These microcomputers have terminal emulation capability as well as the capability to transfer files up and down from the central mainframe. Another 3 to 4 sets of stand-alone microcomputers are also provided to each school to enable teachers to make use of the microcomputer-based software such as word processing and School Item Pool systems.

3) Implementation Approach

School Link systems, unlike conventional systems, have hundreds of schools as users. Although the Ministry of Education sets broad guidelines on how schools should function, each school may have a certain uniqueness in their operations. It is therefore important to develop systems which can perform the standard functions defined by the Ministry and at the same time be flexible enough to allow schools to maintain their unique characteristics. In achieving this, the project team has to work closely with the Ministry officials, who are responsible for defining the standard functions, as well as school principals and teachers who are in schools. A team of teachers is also seconded from schools into the Ministry to work in the School Link Implementation Team to train teachers in schools as well as to provide the systems development team with first-hand information on the operations in schools.

The introduction of the School Link systems to schools also adopts a cascading approach, whereby for each system 2 teacher co-ordinators from each school are trained by the project team. The teacher co-ordinators are then given the necessary training materials to train the other teachers in

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the school. This approach has enabled us to effectively deliver the system to the thousands of teachers in schools. As the teacher co-ordinators are usually trained computer-club teachers, they are also able to provide first level diagnosis whenever teachers encounter problems while using the system. Problems that cannot be solved by the teacher co-ordinators are then channelled to the Ministry's Help Disk. The third level of assistance is provided by the School Link Implementation Team who can provide on-site support.

Major Benefits of the Project

The benefits derived from such a project are innumerable. For example, the Pupil Management System which has the biggest impact on teachers not only helps teachers to maintain their pupils' bio-data and academic results, it also helps principals in their administration, the Ministry in its operations and the government in policy formulation.

For teachers, the system has replaced manual calculations, editing and printing. The quality of various types of pupils' reports and class reports has also improved in accuracy and presentation. The computerization of pupils' information has streamlined various types of school documents and also made available to the teachers a better tool for analysing pupils' data and decision making. An example is the ability to analyze pupils' examination results for the purpose of allocating them to a class or course which suits the pupils' academic abilities.

For school principals, the computer communication with headquarters reduces the number of trips they have to make to headquarters for collection and submission of forms and documents. AS the volume of manual mail is reduced, time spent on processing mail and filing it is also reduced.

At the Ministry level, the central Pupil Data Bank, which gets its data from the individual schools' Pupil Management System, is important part of the operations of the Various Ministry departments. The posting of pupils to secondary schools, the registration of pupils for Identification Cards and also registration for National Service are some examples of the use of the pupils' data.

The availability of a central source of pupil data is also a valuable resource to top management. Statistics and reports are generated from the data bank to assist the government in making decisions on educational as well as non-educational policies; monitoring of pupils' academic performance and attrition rates so that policies can be formulated to develop all pupils to their fullest potential.

With the major applications completed and implemented, we estimate that the project will save a total amount of time equivalent to 370 school teachers and 50 clerical officers. This works out to be an average of 6 man-days savings per year for each of the 20,000 teachers in schools.

In terms of benefits to schools, the additional time available to teachers will allow them to provide more pastoral care and coaching to pupils as well as more time for teachers to develop themselves by attending

academic and self-development courses. In the long run, teachers will do less administrative and clerical work and more professional work.

The implementation of the project has been smooth and schools have responded very well to computerization. Eventually, all principals, teachers and clerks in schools will be able to work with the computer systems. This, by itself is a major achievement in terms of raising the level of computer literacy in the country.

Sri Lanka

The Computer Education Programme commenced in Sri Lanka in 1983, in schools offering science for the General Certificate of Education (Advanced Level) Examination by introducing a 90 hour course on computer awareness to students during their 12th school year. Initially 112 schools were able to commence teaching computer awareness. Elementary knowledge of microcomputers and their uses and programming in BASIC, were taught during this course.

The School Computer Education Programme is centrally supported in all activities by the Computer Education Project (CEP) of The National Institute of Education (NIE). To date, the following have been accomplished.

- * 293 science schools have been given microcomputer systems.
- * 9 schools have been equipped to serve as resource centres or support centres.
- * 530 science teachers have been trained to teach Computer Awareness.

The Government Action Plan on Computer Education in Schools

So far only the schools offering Science up to the General Certificate of Education (Advanced Level) Examination have been included in the teaching of computer awareness. There are about 450 schools at this level out of the 9,800 in the system schools. But, within the next 3 years steps will be taken to increase the number to 1,784 schools which offer (AL) Arts & Commerce also.

This follows the policy decision to provide computers to all schools having classes up to the General Certificate of Education (Advanced Level) grade irrespective of the subjects offered. Thus schools where children study subjects other than science and mathematics - those offering Commerce and Arts - will also be benefited. These 1,784 schools will be equipped in a period of 3 years.

This extension of the programme entails more than the provision of 2,410 computers to 1,784 schools. It involves the training of teachers for these schools; production of courseware and educational software and the establishment of more resource centres in the provinces/regions (at least another 21, totalling to 30).

A project proposal costing Rs. 152 million (US\$4m) for hardware alone has been submitted for approval.

ISSUES

- 1) Computer Awareness undervalued because it is not an examination subject

Computer Awareness is introduced at year 12, the first year of two

years study before University Entrance examination. This examination is highly competitive and normally 6% of students appearing for this examination will have the chance to enter a University. Hence, the teaching of Computer Awareness to GCE (AL) did not produce the desired result. Students concentrated on examination subjects such as Physics, Chemistry, Botany, Zoology and Mathematics and began to neglect Computer Awareness which remained a non-examination subject.

2) Software needs demanded by the curriculum

As a secondary requirement, especially due to the above mentioned issue, it was decided to support students in their examination subjects by providing educational software.

Non availability of educational software seems to be a major drawback in successfully implementing this project. The reasons can be many and varied. For instance, software development and production are expensive (as the clientele served is small and limited), also slow (as very few educationals have taken to programming and computing very seriously).

Software development procedures have to be based and built up on the latest knowledge and theories of teaching and learning just as much as those of computer technology. Appropriate skills and expertise including theories of learning, knowledge of computer hardware and insights of basic programming are needed for educational software development to be effective.

Therefore, development of educational software is both expensive and time consuming. Hence, it cannot be expedited.

Development of educational software is now receiving priority. Some activities are taking place in this direction. Certain topics from the curriculum are selected and a few educational software packages have been developed.

Most of the countries in Southern Asia have closely related science and maths curricula. Non-availability of educational software happens to be a common problem. Hence, it will be a worthwhile idea to think of the larger market for the production and distribution of software. Sharing of experiences could be on the same basis.

3) Shortcomings

- * The supply of computers and relevant accessories have not been completed as shown in the plans.
- * The machines/systems already supplied are not always compatible and the same software cannot be used on them, even if available in sufficient quantities.
- * The computer software development laboratory (and therefore regular production of it) is long overdue.

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- * The teachers undergoing initial training in computer education have not been encouraged to utilize Computer Based Teacher Systems in teaching popular subjects of the curriculum.
- * Where all or most of required facilities are available, 30-40 students have to share one computer during the time set apart for computer activities.

4) Medium of instruction

Another constraint is that the language in which student is learning and the language in which software is presented are different.

Approximately 80% of students are learning through the Sinhala Language (native language of the majority ethnic group) and the rest are learning in the Tamil language (native language of the principal minority ethnic group).

Yet at a time when computer education software cannot be produced in sufficient numbers in the English language for the G.C.E. courses, the extension for the use of Sinhala and/or Tamil is a further constraint.

TRENDS

1) Indigenous Software Development

The effort to find solutions to the above issues by development of icon-driven software packages is a major break through.

The value of visuals in gaining or acquiring literacy and numeracy has been known to mankind from time immemorial. But, it is only recently that scientific studies are being carried out in ascertaining the element of visual literacy, the factors affecting it and the need to adopt visual testing methods for those educated using the powerful dimension of visual literacy, etc.

In such a situation, the importance of icon-driven packages cannot be over-emphasized. Currently some experiments are being conducted in our laboratories in the production and utilizing of icon-driven packages.

2) Word processing in Sinhala

Computer, literate teachers cannot ignore the importance of Information Technology. It is about time that teachers of Computer Awareness undertake "informed speculation" on the "office of tomorrow" (the electronic office). Most of the computer skills could be transferred through user friendly software applications. Introduction of Sinhala/Tamil word processing will be such an opening.

SUMMARY OF SURVEY

A study conducted by CINTEC (Computer and Information Technology Council) in 1989, to investigate the current computer education programme in Sri Lanka includes the following findings:

1. Since the trend is towards MS-DOS application packages it is useful if IBM PCs or compatibles are made available to all schools.
2. Computer assisted learning is more appropriate, therefore relevant software should be provided.
3. Students are not interested in programming at all.
4. Computers should be used as an aid in learning and teaching.

Thailand

1. Present Situation of Computer Education

At the school level, two computer courses, namely, "Introduction to Computers" and "BASIC programming", were implemented in 1985 as part of the elective courses under the Mathematics subjects at the upper secondary school level. Due to the impact of the rapid development and improvement of computer technology as well as the progress of software development, the two existing computer courses were soon considered to be insufficient for the students needs. Students at the upper secondary school level are the youngsters who will be faced with the challenges of tomorrow's highly sophisticated technology. Therefore, the Ministry of Education realized the computer training prepared for their teenagers needed to be modified. The preparation of end-users of computers as well as programmers needed to be emphasized.

In 1987, the Ministry of Education agreed on a plan to change the existing curriculum. A change has been made to raise computer education from its previous position as an elective course in mathematics to its current status as a subject on its own. The two previous computer courses were revised and expanded into 10 courses as follow:

1. Introduction to computer(including word processor package)
2. Introduction to electronic spreadsheet package
3. Introduction to database package
4. Introduction to programming concepts
5. Advance to electronic spreadsheet package
6. Advance to database package
7. BASIC Programming language (I)
8. BASIC Programming language (II)
9. PASCAL Programming language (I)
10. PASCAL Programming language (II)

Each of the courses was designed to earn 2 credits (4 periods per week). All the computer courses were designed to emphasize hands-on activities.

The first two courses have been implemented since May 1989, and the third and fourth since May 1990. The next four courses will be implemented in 1991, and the last two course in 1992 academic year.

In order to offer these computer courses officially, a school must reach the requirements of having microcomputers at least one set of microcomputers per five students, and at least one qualified teacher or trained teacher who would be able to teach the offered computer course(s).

The new structure of the computer curriculum has the advantage that all secondary school students have more opportunity to select computer courses to serve their own needs, such as end-user competences or basic knowledge and skills for future professional programming. The present situation, with respect to computer use at the secondary school level, can be revealed from a recent survey conducted by the Department of General Education and is shown as follows:

Target Schools: Upper Secondary Schools

Number of Computer Courses Available: 10 courses

Total Number of Upper Secondary Schools: 863 schools

Number of Upper Secondary Schools Equipped with Computers:
164 schools (19.00%)

Number of Computers Installed: 1,218 sets.

Number of Computer Teachers: 967 teachers.

Types of Computers: 8-Bit Computers: 37%
16-Bit Computers: 63%
Famous computers : - IBM compatible
- Fujitsu
- Apple II

Sources of Purchasing Budget:

66%: Donation from Parent-Teacher-Associations and Alumni Association
34%: National Budget

Utilization of Computers in Schools :

82%: for computer courses
18%: for administrative activities, e.g. personnel, registration, finance, library, etc.

2. Use of Computers in Schools : Research Finding

In 1986, a survey on the availability of computers in government schools was conducted by the Department of General Education. Results showed that microcomputers were available in 92 out of 734 government schools at the upper secondary level. The number of microcomputers owned by schools ranged from one to thirty-three. Within this sample school group, the use of microcomputers was reported mainly for teaching and learning computer courses. Very few schools reported that they applied microcomputers to assist instruction in other subjects. Those schools which had less than three microcomputers reported the main purposes of using computers were for administrative work, management, and records keeping (Wattanawaha, Sawetamalya, and Shinatrakool, 1986).

In order to obtain more information on the existing conditions regarding computers and computer education in government secondary schools and teachers' colleges, another survey and case studies were conducted in 1987 (Wattanawaha, Shinatrakool, and Sawetamalya, 1988). The studies were part of the 'Computers in Education' project organized by RECSAM (Regional Center for Education in Sciences and Mathematics) under the support of the Australian government (RECSAM, 1986).

The findings from the survey and the case studies revealed that most Thai government schools realized the need to have computers and to use computers in schools in order to provide computer education to their stu-

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dents. Most principals of urban schools perceived the need to introduce computers to schools, but not those in rural schools. However, principals and teachers in charge of computers from both urban and rural schools perceived the need for a plan for expansion.

According to the survey, government schools in Thailand began to acquire computers in 1983. The acquisition of computers was rapidly increased until 1985, when the trend declined, due to the regulation issued by the National Computer Committee which was highly concerned with the economics stabilization of the country. The introduction/expansion plans in schools from this study seem to be unfeasible because of several constraints. At the time when this study was conducted, only 84 out of 763 government schools (11.01%) had computers. Among these schools, only five teachers were qualified to teach computers. Other teachers involved in computer education mostly gained their knowledge through self-study and in-service training offering by private computer companies. This finding identified the lack of qualified personnel. Since one requirement of the regulation for the acquisition of computers is that there must be qualified personnel, this factor would have caused the delay in the introduction or expansion plans of computer education in schools. There is clearly a need for teachers' college to offer more training programs to produce computer education teachers.

Without financial support from the government, financial support from other sources such as PTA or congressman, plays a vital role in the acquisition of computers. To ensure that there is an effective program in computer education, a continuing budget needs to be provided for the facilities, maintenance, supply and services, etc. The schools with strong PTA support are able to acquire and maintain adequate computer facilities for effective computer education programs. Schools that acquired computers from donations without continuing budget support are now facing problems of maintenance. Those schools that are poor and have no support from any source can hardly introduce computer education to their students. Such problem of disparity among these schools can be solved if financial support from the government is evenly distributed to schools.

Regarding the utilization of computers as a tool in schools, the findings revealed that schools used computers in several kinds of school tasks i.e. strong and retrieving teachers' records, using computers in evaluation and finance and teaching computer courses. It is possible to use a computer for many kinds of managerial tasks if only one computer is available in a school but it is impossible for the purpose of teaching computer courses. Therefore very few schools (5.37% of all upper secondary schools) use computers for teaching and learning. This evidence is supported by the fact that most schools reported a lack of hardware.

3. Computer Assisted Instruction

For the development of CAI, a total of 23 schools (20 urban schools and 3 rural schools) reported that they had developed their own CAI. Programming language used was BASIC. Software used as developing tools were dBASE II, dBASE III+, Assembly, Show partner, Prodesign II, and AUTOCAD.

However, only five schools reported they used CAI in five subjects: mathematics, sciences, computer, social studies and English. Among these subjects, CAI was used most widely in mathematics. Topics mentioned were natural numbers, integers, absolute values, operations on integers, skills on calculation, permutation and combination, quadratic equations, and trigonometry.

CAI was used in the following Physics topics: projectile; kinetic theory; vector; simple harmonic motion; momentum, and electostatics. Topics mentioned in computer studies were programming development and BASIC programming. The use of CAI was reported in only one topic each in Social Science and English. These were constellation exploration and vocabulary respectively.

This CAI software was used by teachers for group instruction in the classroom. Most topics were used once a week. The target group was the upper secondary students rather than lower secondary students. Major problems reported by teachers in connection with the use of CAI were lack of hardware, lack of software, limited space and lack of manuals.

The development and use of CAI in schools seems to move at a slow pace due to the major problems of inadequate hardware and experts' cooperation. Another critical problem which hinders implementation is the nature of the Thai language, since public domain and commercial software are in English which is very difficult to change into Thai.

In order to encourage school teachers in the application of computers to assist in instruction, IPST holds a yearly seminar on microcomputer-assisted instruction. The seminar concentrates on science and mathematics at the secondary school level. It is open to teachers with interest and experience in educational software. The purposes of the seminar are as follows:

- 1) To search for the appropriate techniques and methods for the effective use of microcomputers to assist instructions in science and mathematics.
- 2) To exchange knowledge, ideas, and experiences on the use of microcomputer-assisted instruction in science and mathematics:
- 3) To collect and disseminate CAI programs in science and mathematics.

The first seminar was held in September 1986. A total number of sixty-six participants from universities, teachers' colleges, and schools attended the seminar. About half of the participants had experience in program writing. They presented altogether thirty-six programs of which there were 16 program in mathematics, 9 in science, and the remaining 11 programs were miscellaneous.

The second and third seminars were held in October 1987 and April 1988, respectively. The number of interested participants increased while the number of experienced participants decreased. According to the records, 135 participants joined the seminar with 115 observers and 22 presenters. The

number of teacher-written programs presented was reduced to 20 with 6 in mathematics, 8 in science, and 6 miscellaneous. In the third seminar, there were 167 participants with 140 observers and 20 presenters. The number of programs presented was 24, with 6 in mathematics, 4 in science, and 12 miscellaneous.

The atmosphere during the seminars was enthusiastic and pleasant. The events seemed to signify a promising future for CAI development. However, most presenters were the same people, and very few programs were written in the Thai language. Therefore, IPST realized that urgent attention should be given to training interested teachers on the techniques of educational software development, especially in the Thai language. The training should emphasize CAI development through the application of existing computer packages rather than through a computer programming language. Such training will strengthen the existing yearly seminar on CAI and also provide a good foundation for CAI as far as mathematics and science are concerned.

4. Main Issues and Problems

One of the crucial problems in the use of CAI in Thailand is the Thai language. Since foreign educational software can not be used directly in Thai schools, development of Thai language software is needed. Unfortunately, educational software development is very time consuming. The suggestion might be made that the exchange of self-made software among teachers could help to solve this problem. Unfortunately, there are several types of Thai standard codes. So, exchange of teacher-made software is not as easy as one could expect. To promote the wider use of CAI, only one standard Thai-code should be used. Some experienced teachers attempted to develop an authoring system which they hoped would facilitate Thai language courseware development. At the moment, the Thai authoring system is not as good as some foreign authoring systems. However, there are many good software applications available on the market which can be used directly in teaching and learning science and mathematics, such as MathCad, Minitab, Smartwork, etc. These application packages are very popular in Thai educational institutions, especially in the universities.

The approach to the use of computers in schools is another issue. There is discussion about whether it should focus on: learning about computers, learning computer programming, or learning with computers. Meanwhile it has been accepted that all school students should know what a computer can do and be able to manage or control a computer through a computer programming language, or by using some key commercial software. These topics should comprise the study of one or more computer courses. But as the role of computers undergoes rapid change in everyday life, all students studying other subject areas should be able to make a full use of a computer for assisting their studies.

While computer assisted instruction has proved to be more effective than traditional learning, the careful analysis of cost-benefit among various approaches is still necessary through a research and development project. It is important that the side-effects and possible negative impact of computers on human learning should also be considered.

5. Future Trends

Concerning computers for education, the following plans have been proposed. These are:

- a) With the impact of computers on the Thai society, IPST, under the Ministry of Education, plans to develop computer curriculum for lower secondary school level as well as for primary level.
- b) Both pre- and in-service teacher training should be more carefully planned in the related educational institutions. Cooperation between government and the private sector should be considered in the plans, so that teachers can keep up to date with the latest computer technology.
- c) Qualified personnel should be well prepared to up-grade the standard of teaching and learning computer education. IPST plans to establish a teacher-training center to serve this purpose. It is expected that the training will prepare teachers for teaching computer courses and for developing appropriate CAI software in science and mathematics. Moreover, this center will serve as a clearing house for educational software for all science and mathematics teachers.
- d) Research and development into innovative approaches to computer curriculum and instruction will be conducted. This will ensure that there is optimal cost effectiveness, reasonable allocation of resources and equity of educational opportunity.

Appendix C: Introduction of Computers in Education: a first description of trends

Willem J. Pelgrum and Tjeerd Plomp

In 1989, the IEA Computers in Education study collected data on computer use in elementary, lower- and upper secondary education in 22 countries. Although all data sets from the participating countries have not yet been received, this paper contains a description of trends based on data from 15 countries.

Because the process of the cleaning and weighting of the data are not yet completely finished, we can not yet provide tables and figures.

The major questions that will be addressed are the availability and the use of hard- and software, the problems experienced in introducing computers in schools and the attitudes towards computers of the principals in the sampled schools. The results show that in the past few years the number of schools equipped with computers and the number of computers available in schools increased substantially. Despite this fact, computers still are used by only a limited number of teachers, and the most prevailing type of use is teaching students about computers; the integration of computers in existing subjects is developing quite slowly. The major problems that are experienced in schools deal with the lack of sufficient software of high quality and sufficiently trained teachers.

Introduction

The 1980's have shown a rapid increase of the informatization of most societies. The idea that computers are playing an important role in the lives of every citizen is no longer discussed. However, the question how education should react to these developments and what role computers can and should play in schools is still an issue of major debates. Several theoretical perspectives on the role of computers in education have been unfolded and many claims exist as to the potential power of computers as instructional aids.

Many countries have adopted policies for the systematic introduction of computers in education. However, the major question still is: how should new information technologies be introduced in education and to what degree are the expected effects of policies actually realized in educational practice.

The Major goal of the Computers in Education study (Comped) of the International Association for the Evaluation of Educational Achievement (IEA) is to collect longitudinal and crossnational comparative data in order to contribute to the evaluation of policies on (the introduction of) computers in the countries that are participating in the project.

We will give a description of the design of the study and will describe trends for those educational systems for which data sets were available by June 1990. These educational systems are: Belgium-Flemish,

Belgium-French, China, France, Greece, Hungary, India, Israel, Japan, Luxembourg, The Netherlands, New Zealand, Poland, Portugal, Slovenia, Switzerland and the U.S.A. The trends presented will be limited to those schools that are using computers for instructional purposes and to data on school level provided by principals and computer coordinators.

Theoretical background

The framework for the study consists of concepts derived from systems theory, curriculum theory and theories with respect to educational change.

Coleman (1984) refers to the concept of pluralistic educational decision making, which means that the functioning of the educational system depends on decisions taken by several interacting persons and agencies. The most common distinction between levels of educational decision making is the one between macro-, meso- and micro levels, on which can be distinguished respectively higher order administration (such as the ministry of education, or regional or state authorities), school administration, subject departments within schools, individual teachers and students. How these different levels affect each other can be illustrated with reference to a distinction between different curriculum levels. This distinction differentiates between the intended, implemented and attained curriculum. The intended curriculum refers to the curriculum plans, which may be laid down in official documents or which may exist as shared conceptions of what the important curriculum content is. The implemented curriculum consists of the content, time allocations, instructional strategies, etc. which the teacher is actually realizing in his/her lessons. The attained curriculum is defined as the cognitive skills and attitudes of students as a result of teaching and learning.

Finally the functioning of education can also be studied from the perspective of stages in the process of educational change. Fullan (1982) distinguishes orientation, adoption, implementation and incorporation as major stages in the ultimate implementation of an educational innovation and identified from an extensive literature review the factors which are relevant in each stage. In this study attention is especially paid to the factors which are influencing the adoption and implementation processes.

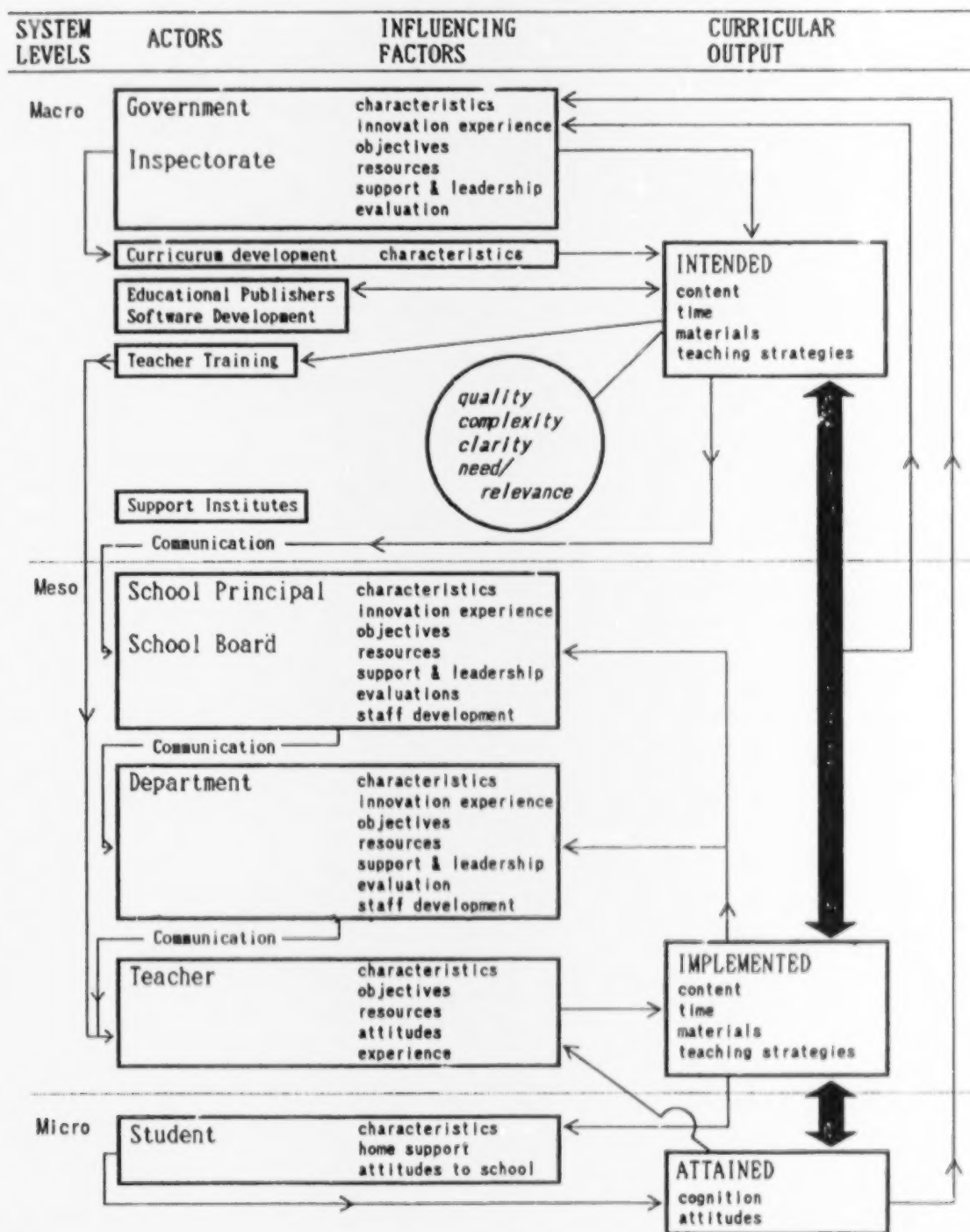
This study incorporates the three different perspectives which are described above. The global conceptual framework for the study, in which the three perspectives are related to each other, is depicted in Figure 1.

The framework in Figure 1 identifies the actors which operate at different levels in an educational system. It is assumed that the different educational system levels influence each other via the curricular products which can be identified at each level. The curricular outputs at the macro and meso level can be conceived as mechanisms for directing the outcomes at student level. Different processes (indicated as influencing factors) derived from the literature on educational change, mediate and determine the characteristics of the curricular products at several levels. The picture illustrates that different sub-systems interact (sometimes mediated via other sub-systems) and that the "behaviour" of a certain sub-system can only be understood if context information about "neighbour" sub-systems is available.

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Certain factors in the model may be at the same time relevant as primary variables and as context variables.

Figure 1



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So the implemented curriculum may be important in itself when studied from an implementation perspective, but at the same time it may be conceived as context information when one is interested in studying student outcomes.

We have characterized the educational system in terms of levels of decision-making and capacity to effect changes. The framework we are proposing reflect the hierarchical structure of most educational systems, but acknowledges that decisions which promote or inhibit the implementation of computer-related curricula are made at all levels, which may cause discrepancies between the different curricular definitions. An identification of these discrepancies may in itself be an important starting point for improvement measures in education.

From the theoretical perspective described above, it follows that many factors are expected to be of potential influence in determining the nature and degree of computer implementation in schools. The questions as to how these factors determine the ongoing innovations is an empirical one and it is hoped that in the end the Comped survey will contribute to a better understanding of the fit of the frame work for explaining to what extent and for which purposes computers are being used in schools.

The design of the study

The study consists of two stages. The first stage (1987-1990) is meant to give a description of computer use by collecting data on school- and teacher level. The second stage of the study (1990-1994) is intended: (1) to replicate measures collected in the first stage in order to study developments over time, and (2) to collect data on student level in order to assess the effects of using computers. As this paper focuses on part of the data collected in stage I, we will give here only a description of the design issues involved in that stage.

Populations and samples

In general, the populations of interest for this study are located in primary, lower secondary and upper secondary education. Although the data collection in stage I was confined to the level of schools and teachers, the longitudinal character of the study required that the populations are defined in terms of student characteristics. The definitions are such that they match as closely as possible the definitions which were used in earlier IEA studies. For Comped the following population definitions are proposed for stage II:

Population I: students in the grade in which the modal age is 10 years (if more than one grade has a modal age of 10 years, the grade with the largest number of 10 year olds should be taken)

Population II: students in the grade in which the modal age is 13 years (if more than one grade has a modal age of 13 years, the grade with the largest number of 13 year

olds should be taken)

Population III: students in the final year of secondary education

During the first meeting of participants in 1987, it was decided that the data collection at school and teacher level in stage I should be aimed at grade ranges which contain the target grades implied by the population definitions plus and minus one year for population I and II, and minus one year for population III.

In most countries the sample of computer using schools is sufficiently large to obtain good national statistics.

Instruments

Table 1 contains an overview of all instruments used in stage I of the study.

It should be noted that the teacher questionnaires for the three existing subjects have the same content except for the specification of the area in many questions and the topics for which computers are used.

The trend description in this paper is mainly based on the School and Technical questionnaires for population II, although some reference are also made to other populations and questionnaires.

Table 1: Available instruments per population

Population	Instrument	Respondent
All	National Questionnaire	National Research Coordinator
I	School Questionnaire	Principal
	Technical Questionnaire	Technical person
	Teacher Questionnaire	Teacher (grade 4-6)
II	School Questionnaire	Principal
	Technical Questionnaire	Technical person
	Teacher Quest. subject*	Subject teacher (grade 8)
	Comped Questionnaire	Teacher (grade 7-9)
III	School Questionnaire	Principal
	Technical Questionnaire	Technical person
	Teacher Quest. subject*	Subject teacher (final grade)
	Comped Questionnaire	Teacher (final/prefinal)

*: Subjects are: mathematics, science and mother tongue

Participating educational systems

Table 2 contains an overview of all educational systems participating in the study. As not all systems participated for all of the populations specified above, the populations that were included are listed as well.

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Table 2: Participating systems by population

Participation in Population			
System	I	II	III
Austria	—	—	✓
Belgium (Flemish)	—	✓	✓
Belgium (French)	✓	✓	✓
Canada (British Colombia)	✓	✓	✓
China	—	✓	—
France	✓	✓	✓
Fed. Rep. of Germany	—	✓	—
Greece	—	✓	✓
Hungary	—	—	✓
India	—	—	✓
Israel	✓	—	✓
Italy	✓	✓	✓
Japan	✓	✓	✓
Luxemburg	—	✓	—
Netherlands	✓	✓	✓
New Zealand	✓	✓	✓
Poland	—	—	✓
Portugal	✓	✓	✓
Slovenia	—	—	✓
Spain	✓	✓	✓
Switzerland	—	✓	✓
U.S.A.	✓	✓	✓

RESULTS

The availability of basic computer materials

The availability of hard- and software is an important condition for the introduction of computers in education. Although in some countries schools started with computer education without the access to computers, these applications are rather scarce at present. In the sections below, we will describe the availability of these materials and present some indications of the quality.

Hardware

The percentages of schools using computers at elementary and secondary level for instructional purposes varies across the countries from almost 0 - 100%.

The number of computers in a school conditions the way computers can be used in the teaching/learning process. On class-level, the computer-student ratio determines whether whole class activities for certain applications are possible. Although opinions differ somewhat, a ratio of 1:2 is generally accepted as a sufficient condition for using computers in whole-

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class activities, the data show that in many educational systems in secondary schools, on the average, the number of available computers is just large enough to have only one class at a time using computers (only the U.S.A. is an exception with an average of about 30 computers per school). In elementary schools the number of available computers is much lower. This means that at present there are not many possibilities for using computers on a frequent basis throughout the school curriculum.

This can be illustrated with an example based on the computer-student ratio. On school level, the computer-student ratio determines the amount of access students (classes and teachers) have to the available computers. For a school of 1500 students with 20 computers (assuming a class-size of 25 students and 35 lesson periods of 50 minutes per week and an acceptable computer-student ratio of 1:2.5) the maximum access-time per week per class would be roughly 1.2 lessons for all possible activities. The computer-student ratio can be used to get an idea about the availability of computers for students.

Some first calculations show that in most countries in lower secondary schools possessing computers, about 6 computers for 100 student are available. We expect this number to be an overestimate, as the ratios are based on only the number of students in grades 7, 8 and 9 (lower secondary education), while many schools have a grade range 7-12 and because the number of computers not in use have not yet been taken into account in these calculations. Although the estimated computer-student ratio indicates that computer using schools possess meaningful number of computers, it illustrates at the same time that the access to computers is still relatively limited.

Beside the number of computers in a school, the quality of the available hardware is another important factor influencing the potentials of computer use in a school. A first rough indication for answering this question can be obtained by looking at the type of machines that are available in the schools. Each participating school was asked to list type/brand of each available computer and the number of computers in the school. The type/brand was coded according to the following scheme;

- 1 IBM 8080, etc.
- 2 Z-80, etc.
- 3 other 8-bit processor
- 4 IBM 80286, etc.
- 5 Motorola 68000
- 6 IBM 80386, etc.
- 7 Motorola 68000+, etc.
- 8 other processor types

Categories 1-3 concern 8-bit machine, while categories 4-7 can be characterized as the more up-to-date machines. The data for lower secondary schools indicate that in the European countries such as Belgium, Greece and the Netherlands IBM-compatible systems are dominating, while in France, Luxemburg and the U.S.A. other 8-bit machines are dominating. The relative large amount of other 8-bit processors in the U.S.A. (more than 80%) mainly consist of Apple-II computers.

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Another indication of the quality of the available hardware can be obtained by looking at the problems reported by the respondents with respect to hardware. It appears that the lack of availability of hardware (computers as well as peripherals), and the limitation of computers are experienced as serious problems by many principals and computer coordinators.

Software

The availability of software is a necessary condition for working with computers. An important distinction with respect to types of software is between general purpose software (like word processors, spreadsheets and database programs) that can be used in different contexts and more specialized subject matter oriented software. Especially the last type of software is important for enabling the use of computers in existing subjects. We concluded that general purpose software is broadly available in computer using lower secondary schools (mostly in more than 70% of the schools) in most of the countries. In all countries more software is available for introductory computer education (in at least two-thirds of the schools). There are many differences between countries in the availability of software for existing subjects. In lower secondary schools especially in the U.S.A, but also in France and the Netherlands, many schools do have educational software available for subject matters areas, like mathematics, science, mother tongue, foreign languages and social studies.

However, from the analyses conducted so far, we know that broad availability of software is absolutely no guarantee for a broad use of computers for instructional purposes by teachers. In the Netherlands, for example, only 11% of the mathematics teachers are using computers for instructional purposes, while these percentage for science and mother tongue are 6% and 16% respectively. Similar or worth figures are found in Belgium and Luxemburg. In his 1985 survey for the U.S.A, Becker (1985) found similar results. This study shows a meaningful increase in computer using teachers in these three subjects (about 45% till 50%). Knowing that many countries, other than the U.S.A, started later with the use of computers in schools, the results of the repeated survey in 1992 are of interest for investigating the developments in other countries.

This study did not record which programs are available in the schools, and whether there is any shortage of particular software or what the quality of the available software is. However, there are some indicators that can throw some light on these questions. These indicators consist of the inventory of problems that were presented to the respondents with the request to indicate which problems with respect to software were experienced as serious in using computers. The data for elementary as well as lower secondary schools show that especially the shortage if software is experienced as a problem by most respondents, while the lack of information about software is the second mentioned problem. This is consistent with the priorities for computer-related expenditures mentioned by computer coordinators: (1) greater variety of instructional software, and (2) more tool software, while hardware wishes are the next ones in priority: (3) more computers in lab settings, and (4) more printers and other peripherals.

However, it should be noted that in elementary schools the lack of

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trained teachers seems to be more pressing.

Experience of schools with computers

It has been often emphasized that the introduction of computers in education is a very complex innovation, that requires the fulfillment of a large number of conditions before any success can be expected. One may argue that the introduction of computers is a matter of time; that schools need time to build up enough expertise, knowledge and experience among teachers before any impact might be expected. Therefore, it is important to look at the experience of schools in using computers. One first indication of experience is the number of years schools are using computers. The data for lower secondary schools show that a tremendous variation exists within as well as between countries. For example, in countries like Belgium, France, Luxemburg, the Netherlands, and the U.S.A, the median is between 5 and 6.5 years; but the 75 percentile varies very much, for example from 6.5 years in the Netherlands, to 8 years in Belgium, 8.5 years in the U.S.A, and even 10.5 years in Luxemburg.

Attitudes of principals towards computers

From the theoretical framework presented above, it can be inferred that attitudes towards computers are a potential influencing factor in determining the implementation of computers in schools. Moreover, especially the attitudes of principals are of considerable interest, as principals are major change agents in a school. In this study, attitudes of principals were measured by presenting them with a list of 15 attitude items, that were extracted from a larger list presented to the teachers. In the construction of this list three dimensions were distinguished, namely, (1) Perceived Educational Impact, (2) Perceived Social Impact, and (3) Training Needs. In order to explore whether these dimensions are present in the data, so far the attitude data of all principals across countries from lower secondary schools were analyzed with principal component analysis.

The data indicate that in general principals from schools that are using computers have more favorable attitudes towards the impact of computers and training than principals from schools not using computers. Although this result seems plausible as far as innovation theory is concerned, it would be too early to infer a causal link at this moment, and henceforth, more detailed analyses are needed for investigating the nature of this seemingly interesting relation. The results of the breakdown by years of experience are also interesting, indicating that the more experience schools have, the more positive principals are about the impact of computers, be it educational or social. At the same time the need for training as expressed by principals seems to be inversely related to the number of years the school has experience with computers: the shorter the experience of the schools with computers is, the more principals express a need for training.

Learning with and learning about computers

The data show that where countries use computers in elementary

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education the trend is towards tool applications, with some emphasis on remediation and enrichment. In secondary schools, however, computers are mainly used for learning about computers and the use of computers as a tool in existing subjects is hardly developed.

One of the major objectives for using computers in secondary schools is to teach students to get acquainted with this new technology. This may involve basic skills, like operating computers but also more advanced knowledge and skills like programming in BASIC or PASCAL, or skills dealing with data handling and information processing.

In the study, we addressed the following questions about the learning of computer related skills by students:

1. In which grades are students learning about computers?
2. In which context does learning about computers take place?
3. What do students learn about computers?

In this paper we present only the first results for lower secondary schools related to the second question.

Contexts in which learning about computers takes place

In many countries, discussions are taking place about the context in which students should learn about computers. One strategy is to expect that students will learn about computers while using them in existing subjects. Another approach is to have (often next to computer use in existing subjects) a separate course that only addresses the learning about computers.

Our data clearly show that in most countries learning about computers takes place in a separate subject. An exception is France where the context for receiving instruction about computers is mainly general technology. Furthermore, in many countries part of the mathematics lessons are devoted to learning about computers. All teachers in the sample (computer education teachers as well as teachers in existing subjects) have been asked to indicate about which computer-related topics they teach, so that this information can be further analysed later on.

Concluding remarks

This paper contains some trends as derived from the IEA survey on the use of computer for instructional purposes in schools. A full report of the study will become available one year from now.

As the data files are not yet fully cleaned, nor approved by the participating countries, only global trends could be presented. More precise data on the issues discussed in this paper can be expected within a few months. Information can be obtained from the first author.